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THE "PHRYGIAN CAP" IN CHOLECYSTOGRAPHY

A CONGENITAL ANOMALY OF THE GALLBLADDER

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INTRODUCTION

IN THE course of the last ten years, while accumulating 165 series of cholecystograms for experimental purposes—each series covering the first phase of emptying of a presumptively normal biliary vesicle—I have noted the recurrence of a peculiar modification of the fundus patterned after the "phrygische Mütze" of German pathologists.

As first described by Bartel,[1,5] the "top" of such a gallbladder (i.e., the fundus) is "bent down to the breaking point (abgeknickte) after the manner of a Phrygian cap*.....Now smaller, now larger segments of the top appear sharply kinked, the bent piece being at times well turned over, like a lappet."

Altogether, Bartel collected some 43 autopsied specimens ranging from infancy (one and a half years) to old age (seventy-eight years) and having a sex ratio of 27 females to 16 males. He stated that they were to be found not too frequently and that they presented "all transitions from a groove to a deep bend caused by a distinctive fold—usually to be found on the medial side." He rightly concluded that such a malformation must represent a developmental anomaly. Further, because some of these cases had a long and narrow gallbladder, suggesting a hypoplastic vesicle, and some had such additional embryologic defects as Meckel's diverticulum, hernia, hypoplasia of the genitalia, etc., and still others were associated with gastric ulcer, tuberculosis of the uterus and intestine, carcinoma of the viscera, etc., Bartel was led to the conclusion that the Phrygian cap was a sign of constitutional weakness—evidence of an organism that had undergone a retardation of development in early embryonic stages.

Little attention was paid to this anomaly, however, until the Graham-Cole method of visualizing the gallbladder came into general use. Then, Bársony[2] reported the occurrence of "Spitzendivertikel." But when two such cases came to operation he could find only a shallow indentation next to the fundus of each vesicle. This he attributed to a thin scar. Otherwise nothing pathological was found. Accordingly, he devised the name "Pseudodivertikel" for any appended shadow the occurrence of which might be explained by traction, folding or kinking of the end of the gallbladder.

The following year, Levine[18] definitely associated a similar cholecystogram with Bartel's description of the "Phrygian cap"

* Also known as the "Liberty cap"—a pointed form of headgear worn with its apex turned towards the front. In ancient Greece it was a sign of the manumission of slaves; in the French Revolution, a badge of patriotism; and on some American coins it still crowns the Goddess of Liberty (New Standard Encyclopedia).

and later in the year Bronner[15] identified characteristic mucosal folds in two such gallbladders that had been visualized by cholecystography and then removed by operation. Following a similar experience Bársony[3] changed the name of this anomaly to "Faltengallenblase."

Meanwhile, Bronner had injected a new note into the situation by suggesting that such malformations are of clinical importance, even in cases of otherwise normal and healthy gallbladders. He based this assumption on the fact that the somewhat

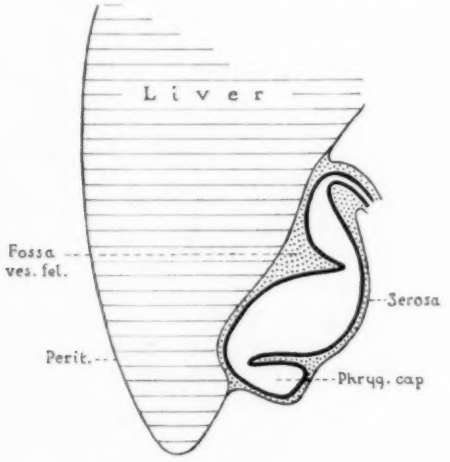

Fig. 1. Sketch illustrating retroserosal type of folded fundus (Phrygian cap) as observed in a seven and a half months' fetus (prematurely born) with a sitting height of 27 cm.

atypical right-quadrant pain which was present in his two cases was relieved by cholecystectomy, his contention being that the kinking of the lower end not only favored retention of bile in the fundus but also interfered with the emptying of the rest of the gallbladder.

Bronner's article was followed, on the Continent, by a series of papers setting forth the "indisputable clinical importance" of this and other similar anomalies (Büdinger,[16] Walzel,[23] Nagel,[19] Sigmund,[21] and others). Büdinger has even coined the term "Cholecystitis mechanica" for the concept of a gallbladder that is rendered pathological by being bent upon itself, whether the kink be a fixed one (either congenital or the result of adhesions), or merely temporary.

As a result of these studies a new interest in the morphology of the biliary vesicle seems to have arisen, so that the literature is now deluged with a flood of fanciful names describing the gallbladder in terms of diverticula, notches, fish-hooks, waterfalls, hour-glasses, garlands, etc. (cf. Bársony, Sigmund). Yet, however useful these terms may be, any scientific analysis must rest upon developmental and pathological anatomy of the liver and gallbladder. Accordingly I have re-examined all serially sectioned human embryos in the Minnesota collection and have begun to collect gross specimens of gallbladders removed at autopsy.

From this preliminary study, it is apparent that there are two primary types of folded fundus: (1) the *concealed* or *retroserosal type*, which is due to an early folding of the epithelial anlage of the gallbladder behind the peritoneal investment of the embryonic fossa vesicae felleae and (2) the *serosal type* which is due to aberrant folding of the fossa itself—a type in which the peritoneum follows the bend in the gallbladder as the pia mater follows the convolutions of the brain. While, in the second type, the folded fundus is somewhat movable, nevertheless the bend is fixed by fetal ligaments, by rudimentary septa or by congenital constrictions of the lumen.

The Retroserosal Type of Folded Fundus

This is well illustrated by Figure 1—a case accidentally discovered by Dr. S. F. Seeley while dissecting the liver of a premature infant in the writer's course on the anatomy of the new-born. So far as I know, this is the first case observed in a fetus. As indicated by the sketch, the mucosa of the gallbladder was bent upon itself in two places, the bend at the fundus being most conspicuous. When first seen, however, it appeared to be a normal gallbladder, since the serosa completely concealed

the kinks. Only when the end of the fundus was accidentally cut off, preparatory to dissecting the vascular tree of the liver, was a transverse septum noted in the gallbladder. When this was sectioned (Fig. 2) it was found to consist of two muscle tunics denuded of mucosal epithelium (following post-mortem degeneration) and separated from each other by connective tissue. Obviously such a condition presupposes an early folding of the epithelial anlage of the vesicle within the embryonic fossa vesicae felleae.

About the time that this specimen was discovered, I roentgenographed a medical student (E. W. H.) whose gallbladder had been visualized previously (Boyden and Rigler[14]) and had been found to exhibit a peculiar modification of the fundus (Fig. 3, *a-c*). This time the student was subjected to a combination of the Antonucci and Sandström methods of administering tetraiodophenolphthalein (as devised by Stewart and Illick[22]) in the hope that the increased density of the shadow would permit the making of cholecystograms from right and left sides. Such proved to be the case and to our astonishment the view made with the subject lying on his right side (Fig. 3, *d*) revealed the same pattern as the fetal gallbladder shown in Figure 1 and indicated that we were dealing with a retroserosal type of Phrygian cap. In both cases the notch between fundus and body faced somewhat posteriorly. The view made with the subject lying on his left side, however, simulated a bilobed gallbladder even more than the anteroposterior view (Fig. 3, *e*). This raised the question as to whether it were possible for a fundus to assume these different appearances unless it were movable, but when the gallbladder was modelled in "plastine" all appearances could be duplicated merely by rotating the model. Therefore this case is believed to be a retroserosal type comparable to that shown in Figure 1.

Incidentally, the rate of emptying of this gallbladder (Case E. W. H., Figs. 4,B and 3, *a-c*) closely approximated the mean established for male medical students of this age (Boyden and Fuller[12]).

Also from the standpoint of Bartel's theory, it is of interest to note that in this otherwise normal and healthy student there remained a vestige of spina bifida in the lowest lumbar vertebra.

A *second case* of this type (A. T.) is shown in Figure 5, *a*, a cholecystogram of an eleven year old girl admitted to the hospital for osteomyelitis of the right leg. At first glance, this case would seem to be quite different from the previous one,

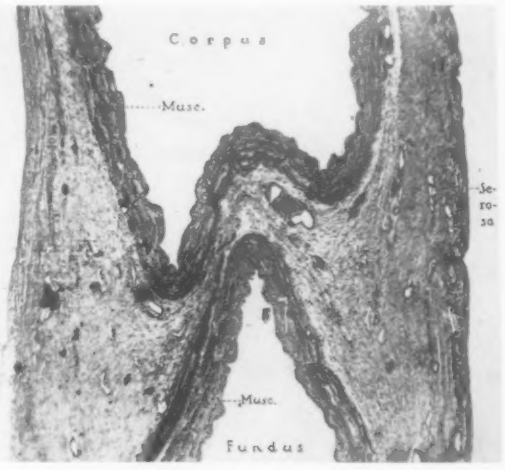

Fig. 2. Photomicrograph of a section of the specimen shown in Figure 1, made at right angles to the septum which separated the fundus from the body of the gallbladder. *Musc.*, epithelial surface of tunica muscularis, denuded of epithelium by post-mortem degeneration. Note fragment of epithelium near apex of cavity marked *Fundus*.

since the fundus points upward and medially instead of downward and laterally. One of the seventeen films in this series, however, shows the characteristic parallel-sided notch between the fundus and body (Fig. 6, A). Also the cholecystograms in this series resemble closely that of a thirty-eight year old physician described by Sigmund[21] (Fig. 6, B), a lateral view of which is shown in Figure 6, B′. When Sigmund's patient came to operation for relief of chronic pain in the right hypochondrium, the gallbladder was found to contain "a partition formed by duplication

of the inner surface of the vesicle." On the basis of the author's description I have added the liver and peritoneum to the outline of the shadow (Fig. 6, B'). This shows that the incisure between fundus and body lies on the anterior surface of the gall-bladder, whereas in the case of the eleven year old girl (Fig. 6, A) it lies on the medial

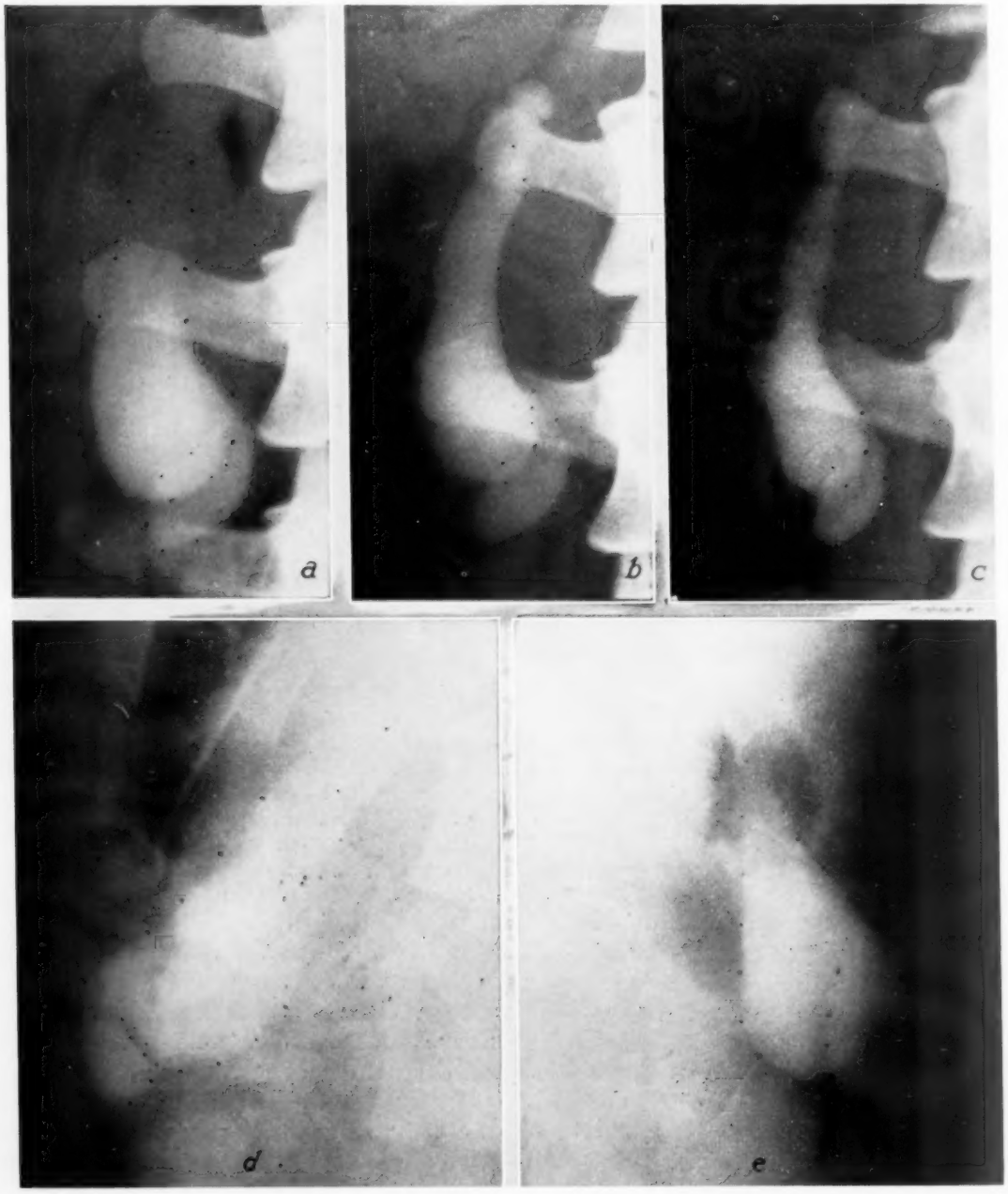

Fig. 3. Cholecystograms of Case E. W. H. (medical student, aged twenty-one, weight 142 lb.). *a*, *b*, *c*, anteroposterior views (Series I) taken 7½, 20 and 38 minutes after ingestion of egg yolk. For rate of emptying, see Case E.W.H., Figure 4, B; *d*, *e*, lateral views (Series II), with subject lying on his right and left sides, respectively. (Series II visualized by Stewart method.) Note similarity of contours in *d* above and in Figure 1.

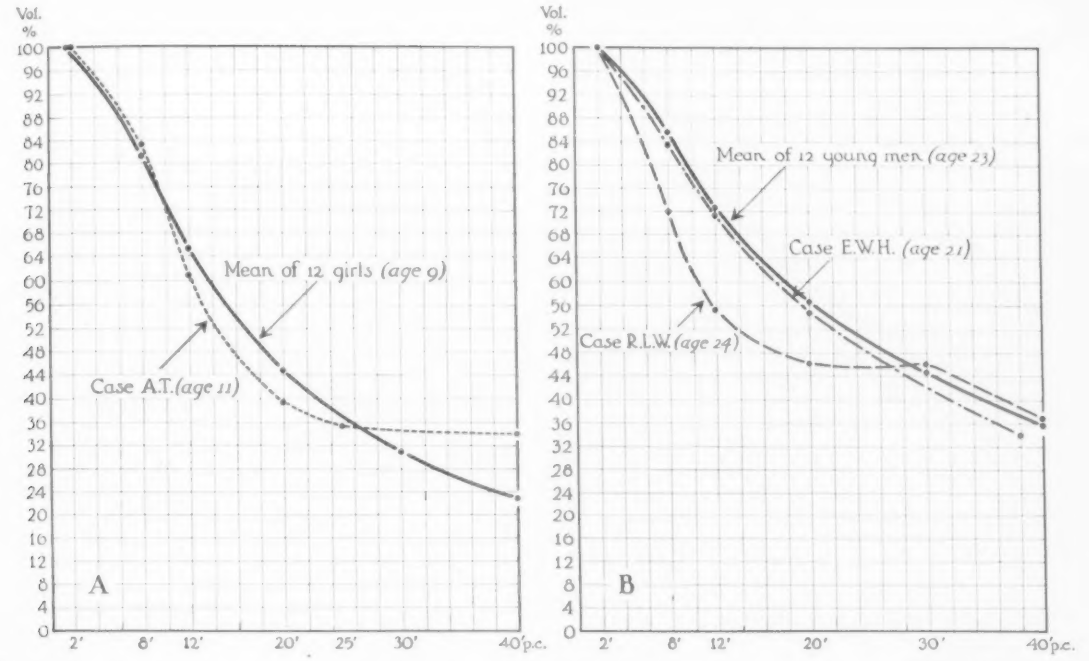

FIG. 4. Graphs comparing the rate of emptying of the gallbladder in 3 cases of folded fundus with the mean rate of emptying for comparable age and sex groups as established by Boyden and Fuller.[12] *Ordinates*, volume of the gallbladder in per cent. (The volume at two minutes after ingestion of egg yolk is considered as unity.) *Abscissas*, minutes after a standard meal of four egg yolks dissolved in milk. For methods of computing the volume of the gallbladder, see reference cited and article by Boyden.[10] A, young girls; B, young men. The graphs cover only the first or principal phase of contraction.

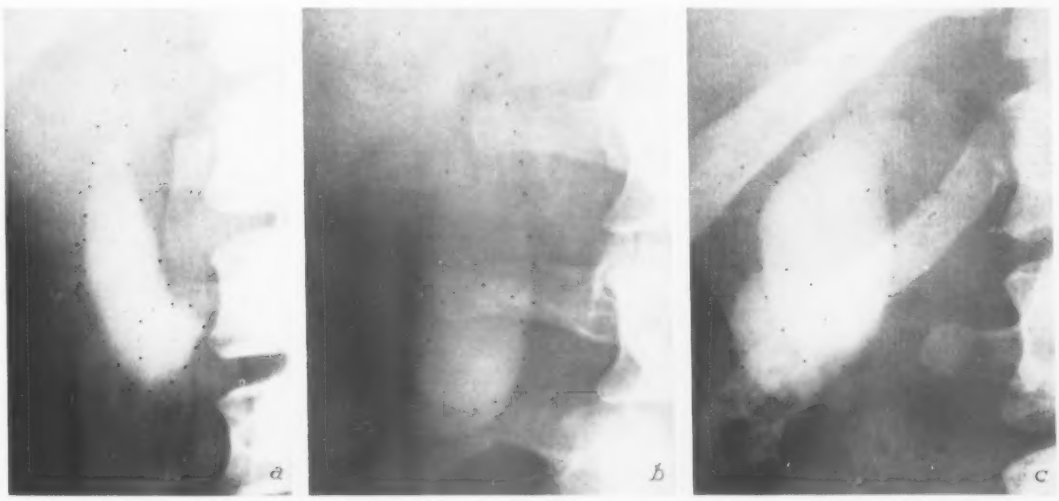

FIG. 5. Cholecystograms (anteroposterior views) of 3 additional cases of folded fundus. *a*, Case A.T., girl aged eleven, hospitalized for osteomyelitis of right leg. Film made eight minutes after meal of egg yolk. For shape of gallbladder at twenty minutes p.c., see Figure 6, A (for rate of emptying see Case A.T., Fig. 4, A). *b*, Case R. L. W., graduate student, aged twenty-four (Series 1 made during fasting). For other views of this same gallbladder see Figure 7, A and B; for rate of emptying see Case R. L. W., Figure 4, B. *c*, Case M. F., primipara, aged twenty-three, five months pregnant; from unpublished series by Gerdes and Boyden, dealing with the rate of emptying of the gallbladder during pregnancy.

(left) surface, and in the case of the medical student (Fig. 3, *d*) it lies on the posterior surface. In the next case to be presented, the notch is laterally placed (Fig. 6, c). The reason for such a variety of appearances will be discussed below in the embryological account of this anomaly.

In the second case, as in the first, the evacuation of the gallbladder compared favorably with that of other individuals in the same age and sex group (Case A. T., Fig. 4, A).

second case of Sigmund's, a forty year old merchant.*

INTERMEDIATE TYPES OF FOLDED FUNDUS

In addition to the 3 cases just described, there are 3 more of presumably congenital origin in this series of 165 individuals. At least 2 of them seem to belong to the retroserosal type of folded fundus, but since no side views are available, they are described apart from the others.

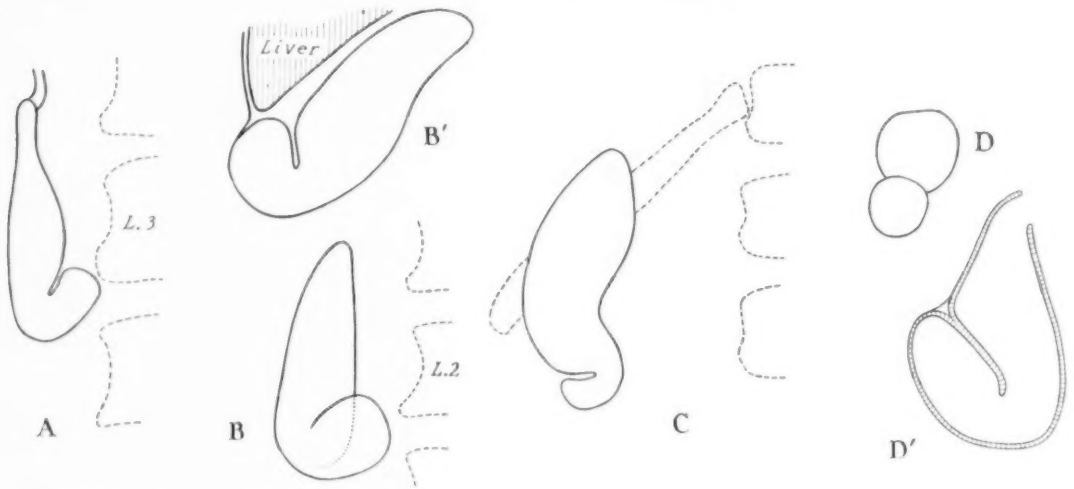

FIG. 6. Additional cases of folded fundus. A, outline of cholecystogram of Case A. T. (see Fig. 5, *a*) made at twenty minutes p.c. B, tracing of cholecystogram of case of thirty-eight year old physician (R. P.) reported by Sigmund;[21] patient suffering from right upper quadrant pain. This is an anteroposterior view made sixteen hours after oral administration of dye. B′, lateral film from same case; liver added in accordance with author's description of relations found at operation. C, tracing of anteroposterior film of Case K. W., boy, aged five, admitted to hospital for treatment of strabismus. D, tracing of anteroposterior film of Bronner's Case 1, a young man, aged seventeen, suffering from cramps under the right ribs. D′, sagittal section of gallbladder of same case, after removal by operation; note septum caused by folding of fundus.

The *third case* is the one shown in Figure 6, C—a tracing of a cholecystogram of a five year old boy, admitted to the hospital for treatment of strabismus. Owing to the excessive amount of gas in the intestines the films were not good enough to be reproduced, but the outline of the gallbladder in Figure 6, C is an accurate representation of a picture taken fifteen minutes after a meal of egg yolk. The volumes of the gallbladder could not be computed in this case but emptying seemed to be normal. In shape and position the folded fundus of this case resembles closely that of the

The *fourth* of the 6 cases (M. F.), that of a primipara twenty-three years old and five months pregnant, is shown in Figure 5, *c*. The uterus in this case was not raised above the umbilicus, so that the shape of the gallbladder cannot be attributed to the pressures of pregnancy. Furthermore, the fundus must have been fixed to the main body of the vesicle, since its position re-

* While these 3 cases are classified provisionally as retroserosal types of folded fundus—on the basis of roentgenograms that reveal the shape of the notch and the close resemblance of these shadows to authenticated cases in the literature—it is obvious that in the absence of direct observation one cannot exclude the possibility that some of these are serosal types.

mained constant during the emptying of the viscus. This gallbladder differs from that shown in Figure 5, *a* in having its fundus turned to the right instead of to the left. Otherwise, it seems comparable. It is interesting, however, to note the different patterns which this type of Phrygian cap may assume in roentgenograms, depending on its position in the body. In Bronner's case, for instance, the gallbladder has the appearance of two overlapping circles (Fig. 6, D), yet when removed and bisected longitudinally it exhibited the typical shape of a retroserosal type of folded fundus (Fig. 6, D′).

The *fifth case* (R. L. W.), that of a graduate student, aged twenty-four, is shown in Figure 5, *b*. Here the fundus points downward and somewhat laterally, as in Case E. W. H. (Fig. 3, *a*). Also in all films made from this individual (three series comparing the relative efficacy of egg yolk, of cream and of milk as a means of emptying the gallbladder) the fundus remained constant in position, indicating that it was fixed to the body of the gallbladder. Figures 7, A and B illustrate its appearance before and after a fatty meal. Its rate of emptying is indicated by the curve R. L. W. in Figure 4, B.

This case, however, somewhat resembles the cholecystogram of a bilobed gallbladder obtained by Ullmann, the first case of subdivided fundus to be revealed by cholecystography (Boyden[9]). Since no cut of this has ever been published, a tracing of the cholecystogram is shown in Figure 7, C. A print of the film was sent to me in March, 1926. In the accompanying letter Dr. Ullmann stated that this gallbladder was explored at operation and presented the appearance shown in Figure 7, D. He referred to it originally as a gallbladder having "a large diverticulum arising from its anterior aspect." Otherwise it appeared to be normal. It is not believed, however, that the case shown in Figures 5, *b* and 7, A is a bilobed vesicle; first, because the indentation does not reach up far enough and second, because of the extreme rarity of this type of anomaly in man.*

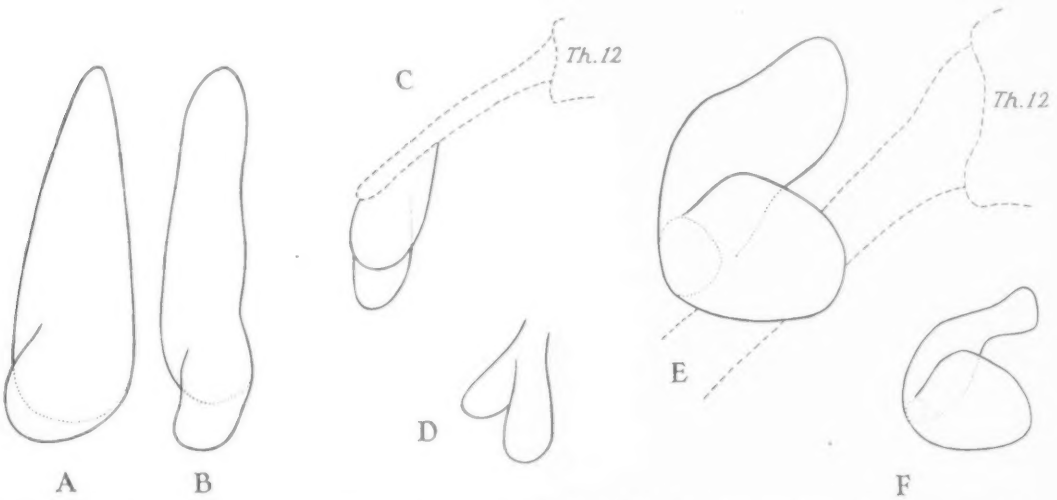

Fig. 7. Comparison of three types of anomalies. A, B, tracings of folded fundus from Case R. L. W. (see Fig. 5, *b*), anteroposterior views made during fasting (Series I) and twenty minutes p.c. (Series II, after egg yolk). C, tracing of anteroposterior cholecystogram of bilobed gallbladder (Ullmann's case, from man aged forty-three). D, sketch of same case as observed at exploratory operation. E and F, tracings of cholecystograms of an hour-glass gallbladder (Case D, W, R.), a medical student, aged thirty. Anteroposterior views showing appearance of gallbladder before and after emptying. Note small orifice between fundus and body.

* As noted in a previous publication (Boyden[9]), no bilobed gallbladder (vesica divisa) was reported in a collected series of over 9,000 cadavers. The only case which I could find in the literature was one figured by Cruveilhier in 1865. Since then at

The *sixth case* to be observed in 165 series of cholecystograms is that of the hourglass gallbladder shown in Figure 7, E and F, from a medical student thirty years old (D. W. R.). The cholecystograms of this case have already been published (Plate 1, Boyden)[10] from the standpoint of their physiological interest.† From a morphological standpoint it is believed that this case represents an exaggerated form of Phrygian cap, probably of the serosal type. Certainly the constancy of position of the fundus during contraction and the small size of the opening between the two parts indicate that we are dealing with a fixed, congenital malformation.

TYPES IN WHICH THE BODY OF THE GALLBLADDER IS FOLDED

In addition to the 6 cases of folded fundus there are 24 series out of the 165 (14.5 per cent) in which the body of the biliary vesicle is so markedly indented as to merit special mention. The more striking forms are outlined in Figure 8. These illustrate various types of "Korpusknickung"—a condition first described by Berg[6] and subsequently found by Nuboer[20] in 5.33 per cent of 75 autopsies of normal gallbladders.

All of them are undoubtedly serosal types, since the relative positions of the

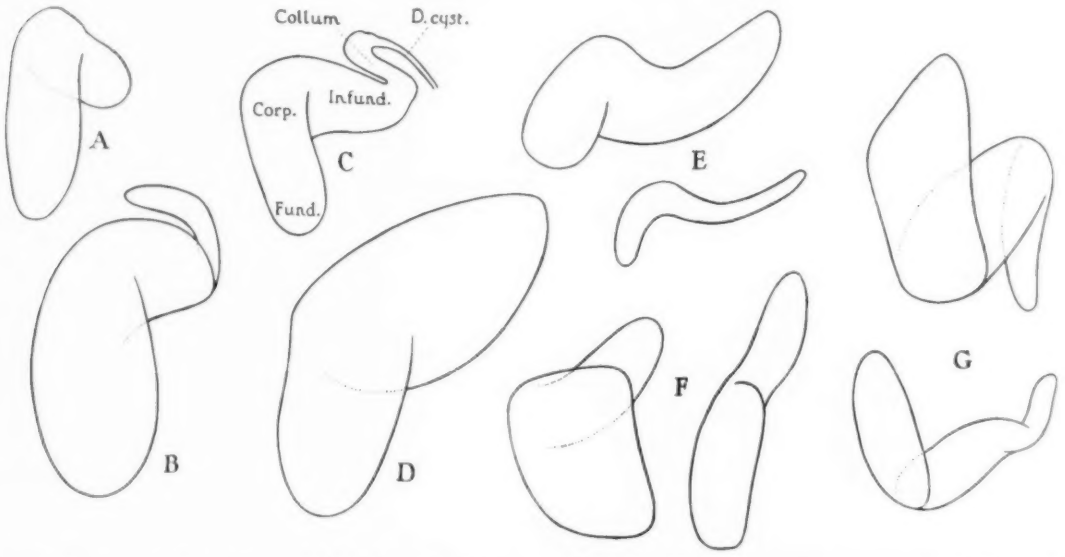

FIG. 8. Representative types of folded gallbladders in which the incisure occurs between the body and infundibulum. All are tracings of anteroposterior films. A, Case C. C. C. (young medical student, Harvard series), at 90 minutes p.c. egg yolk. B, Case E. H. (primipara, aged fifteen, five months pregnant), at twelve minutes p.c. egg yolk. C, Case R. P. (girl, aged six, admitted to hospital for generalized jaundice caused by injury due to a fall), at sixteen minutes p.c. egg yolk. D, Case Th. (woman, aged sixty-four, with carcinoma of cervix), at five minutes p.c. egg yolk. E, Case B. C. (girl, aged ten, with osteogenica imperfecta and shortened thorax), at four and sixty-two minutes p.c. egg yolk. F, Case C. H. S. (medical student, aged twenty-nine, young woman, Illinois series), during fasting and at nine minutes p.c. egg yolk. G, Case Str. (woman, aged seventy-eight, hospitalized for treatment of cataract), at twelve and twenty minutes p.c. egg yolk.

least 2 other cases have been reported (Meyer, 1928; Phillips, Isaac and McDonald, 1931). The commoner, though still rare, double gallbladder with two cystic ducts (vesica duplex) has been reported at least nine times since 1926 when I collected 17 cases (namely, by Braun, 1926; Garofalo, 1927; Wakeley, 1927; Priesel, 1927; Holderman, 1930; Croudace, 1931; Strukow, 1931; Hermann, Hicks and Martin, 1933; Wolfson, 1933).

† This was the case in which the gallbladder contracted for fifty-two minutes after ingestion of egg yolk but was unable to empty itself on account of what was presumed to be a spastic closure of the sphincter of Oddi. At that time it was suggested that the spasm was due to a state of shock induced by the presence of iodine salts. Since then Deissler and Higgins[17] have shown that in animals sensitized to horse serum and egg white, both the gallbladder and sphincteric mechanism at the end of the common duct undergo maximum contraction when the antigen is added and that the sphincteric resistance is great enough to prevent the emptying of the viscus.

two limbs change somewhat, like the opening and shutting of a jackknife, when the position of the subject is slightly shifted. Presumably such forms should not be considered true anomalies, although retention of the characteristic kinks during emptying (E, F, G, Fig. 8) and the occurrence of similarly placed bends in young human embryos indicate that the bends arise early in development as a consequence of somewhat atypical molding of the fossa vesicae felleae. The latter view is substantiated by an autopsy specimen, just received, which exhibits an excavation of the liver behind the lower bent portion of the gallbladder.

The simpler of these forms (A and B, Fig. 8) suggest at first that the bent upper end is nothing but the neck (collum) of the gallbladder which has swung around to the left from its normal anterior position. However, with favorable visualization (C, Fig. 8) or by dissection (B, Fig. 8, Boyden[9]) the neck can also be seen.*

The effect of these bends on the rate of evacuation of the gallbladder seems to be negligible. For instance, the biliary vesicle shown at F (Fig. 8) empties the fastest of any gallbladder in its age and sex group. (cf. C. H. S., Table 3, Boyden and Fuller[12]); that at A (Fig. 8) coincides with the norm (cf. C. C., Fig. 14, Boyden[8]); that at C (a case of icterus) is slower (R. P., Table 2, Boyden and Fuller[12]); that at D is slower, but that at G is faster than the norm (Boyden and Grantham[13]).

* The most accurate morphological description of the human gallbladder is to be found in Aschoff's "Lectures on Pathology" based on Charpy's account in Poirer and Charpy's "Traité d'anatomie humaine." There the neck is defined as the portion between the first Heisterian fold and the cystic duct—a transitional segment connecting the main gallbladder and its duct but demarcated from each by an acute bend (c, Fig. 8). Berg's use of the term infundibulum for the funnel-shaped portion between body or neck, deprecated by some as unnecessary, seems to be justified by the present study; for not only is the body subdivided by an incisure in 24 cases but in a third of the remaining series there is a slight bend and a change in caliber between the lower and upper portions of the bilary vesicle. To these terms—collum, infundibulum, corpus and fundus—Nuboer has recently added the name "pars libera" or "Kuppel." It designates that part of the fundus and corpus which is completely surrounded by peritoneum, i.e., the portion that is not adherent to its fossa. It can exist in gallbladders that do not project beyond the margin of the liver. Nuboer and the writer believe that although this is the most movable portion of the vesicle, it plays no role in the folding of the fundus, since the latter event takes place long before the gallbladder frees itself from the liver.

The remaining gallbladders in the 165 series may be considered typically normal, varying only in minor proportions from the characteristic pear-shaped form. This variance is sufficient, however, to produce sausage-shaped, egg-shaped and spindle-shaped contours.

EMBRYOLOGIC CONSIDERATIONS

In an attempt to find explanation for what seems to be the most characteristic anomaly of the human gallbladder—the folded fundus—I have re-examined some 55 sectioned human embryos in the Minnesota collection, ranging from 7 mm. stages upward. Five of these, which were sufficiently unusual to warrant description, have been reconstructed graphically (Fig. 9, A-E).

The key to the situation is shown at E, a composite drawing of 24 sagittal sections through a 15 mm. embryo. At this stage the gallbladder consists of a solid epithelial tube lying in the mesenchyma of the fossa vesicae felleae. The cystic, common hepatic and common bile ducts have each acquired a lumen, but no muscle or connective tissue tunic has yet appeared. Three normal anterior-posterior bends occur in the mesenchymal bed that encloses the cystic portion of the biliary tract: one, at the summit of the cystic duct—presumably the site of the future separation between the pars glabra and the pars convoluta of that duct; a second, near the site of the neck of the gallbladder—a fold in the epithelial anlage which is not yet formed; a third, at the junction between the body and fundus—a bend that is usually absent in the adult and which is atypical in this embryo because the fundus bends to the left as well as downward (posteriorly). Ordinarily the second and third of these bends become straightened out by the time that the fossa has changed from its horizontal (Fig. 11) to its oblique and definitive position in the body (Fig. 12).

At the earlier period, however, the bends are conspicuous and the third one is be-

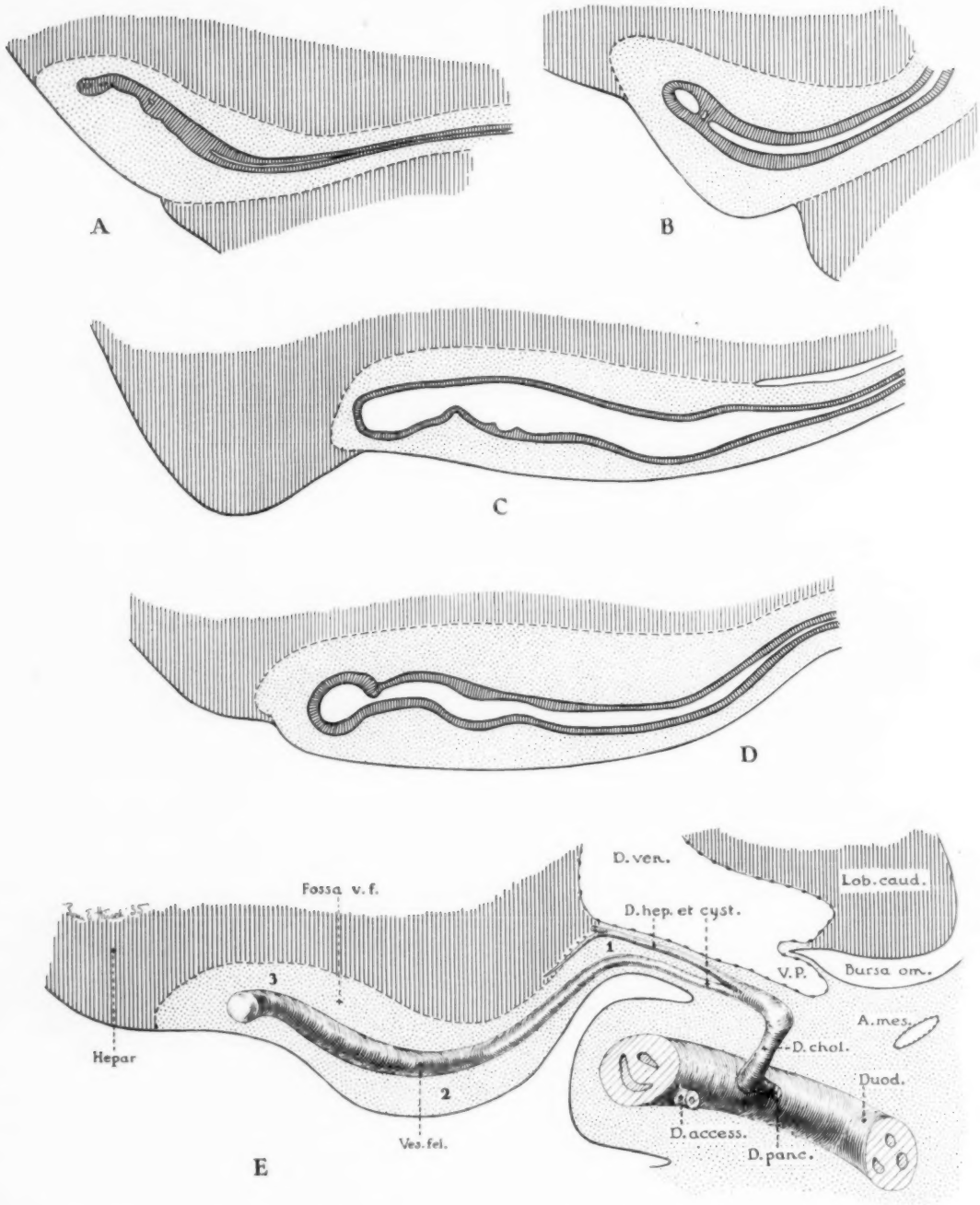

Fig. 9. Graphic reconstructions of the gallbladder and its fossa in five human embryos of the Minnesota collection. The first four are made from transverse sections and show the gallbladder as it would appear in sagittal section (Fig. 11) when viewed from the left side. A, No. 387, 18.5 mm. embryo; B, No. 22, 19 mm.; C, No. 21, 26 mm.; D, No. 375, 29 mm.; E, No. 305, 15 mm. The latter is a composite drawing of 26 sagittal sections, one which is shown in Figure 11. It represents the gallbladder as seen within a transparent slice having the thickness of the aorta. 1–3, three characteristic bends in the fossa during the solid stage in the development of the gallbladder; A and B, the period of vacuolization; C and D, stages in which the lumen of the gallbladder has been re-established. See text for description of initial stages in formation of folded fundus.

lieved to play a deciding rôle in the formation of the Phrygian cap. Two factors seem to be involved. First, there must be a natural variation whereby certain embryos have a longer fossa vesicae felleae than others, thereby permitting full development of the third bend. Second, the corresponding bend in the epithelial anlage of the gallbladder may be accentuated or preserved by a constriction resulting from the method of establishing the lumen. In Figure 9, A, for instance, the lumen is being formed simultaneously at both ends; in the fundus, through vacuolization and in the neck by encroachment of the lumen of the cystic duct. This occurs in such a way that the fundus becomes distended in advance of the adjacent portion of the body leaving, temporarily, a solid plug between the two parts. Should resolution of this plug be delayed, the constriction between the two parts might persist even after the lumen is re-established, as shown in two older embryos (Fig. 9, C and D; Fig. 10). If then, in later stages, the gallbladder should grow faster than its fossa, the fundus would be pushed against the end of the fossa and folded up, in the manner shown in Figure 1, with the notch between fundus and body facing posteriorly. But if the end of the fundus is turned medially, as in the embryo shown in Figure 9, E, then the notch in the adult stage will presumably lie medially (Fig. 5, *a*).

Figure 9, B, on the other hand, suggests a method by which the serosal type of Phrygian cap may be formed. In this case the embryonic fossa is much shorter than usual, as a result of which the third bend in the gallbladder seems to be absent. Furthermore, the distance between the first and second bends is much greater than usual so that the second bend now separates the fundus from the body instead of lying at the neck of the viscus. Finally the whole fossa, as revealed by a wax model of the liver, is transversely placed, with the fundus of the gallbladder turned medially. Should this bend become accentuated by differential growth changes and become fixed by the development of fetal ligaments, a congenitally fixed serosal type of folded fundus would result.* Again, should a constriction develop at the bend, through delayed vacuolization (cf. Fig. 9, B), the hour-glass type of folded fundus shown in Figure 7, C, might be duplicated. Such anomalies must be attributed primarily to a peculiar modelling of the embryonic fossa of the gallbladder.

Fig. 10. Wax model of the gallbladder that was reconstructed in Figure 9, D, to show constriction between fundus and body of gallbladder.

At this point, it might be asked why the folded fundus is peculiar to man—as apparently this anomaly occurs rarely, if at all, in the common domestic mammals; for, in the 10,000 sheep, cattle, pig and cat livers which I once examined, no trace of it was seen.[9] It was noted, however, that each species seemed to have its special variant—bilobed and ductular gallbladders in cats, accessory gallbladders associated with cyst-hepatic ducts in cattle, divertic-

* Dr. Walter H. Ude has just called my attention to a case of folded fundus, detected by cholecystography, in which fetal ligaments were found after removal of the gallbladder. The following day I saw another specimen, removed at autopsy, in which a fetal band passed from the side of the fossa to the fundus, at the point where the latter turned posteriorly. These 2 cases show one way in which a folded fundus may become fixed.

ula of the body and fundus in sheep, ampulla-like enlargements of the neck in pigs, and accessory gallbladders of ductular origin in man. Also it was shown that while the left ventral pancreas of cat embryos sometimes invades the porta hepatis porta hepatis is too narrow to admit it. Similarly the occurrence of a "Phrygian cap" in man may be a consequence of a greater encroachment of the parenchyma of the liver upon the end of the fossa of the gallbladder, thus rendering it more subject

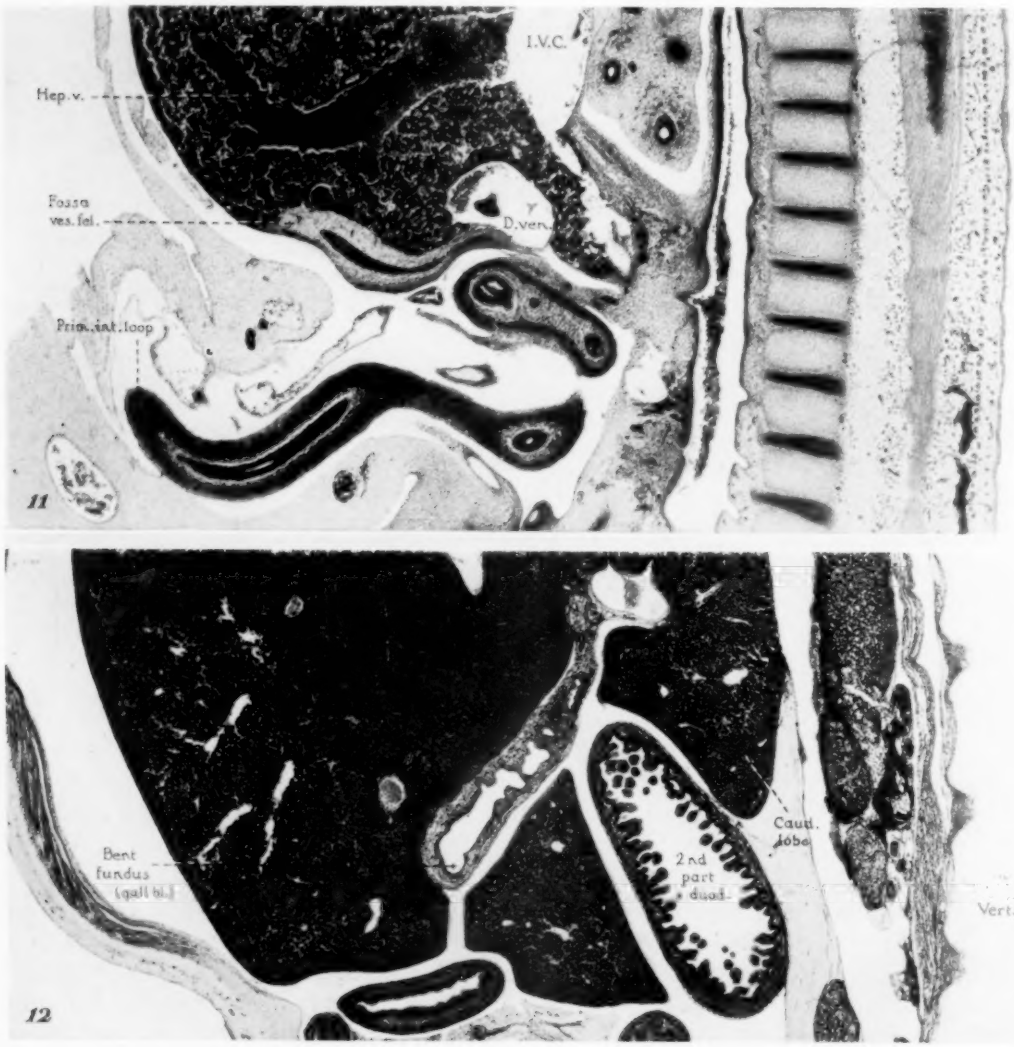

Fig. 11. A parasagittal section through the 15 mm. embryo reconstructed in Figure 9, E. *ves. fel.*, gallbladder lying in its fossa. Note its horizontal position. For key to other structures, see text and Figure 9, E.

Fig. 12. A parasagittal section through a 43 mm. human embryo. Note shift in position of gallbladder to oblique plane characteristic of its position in the adult. Also note slight bend in fundus and the appearance of mucosal folds. In sections adjacent to this, such folds appear to separate the fundus from the body.

to form a pancreatic bladder, the comparable aberrant lobe in the human embryo grows around the duodenum to form an annular pancreas, probably because the

to distortion. Such species differences are not rare. Thus in certain mammals (such as the cat) the epithelial anlage of the cystic and common ducts never goes through the

solid stage which characterizes human development. Or there may be a species difference in the rate of development. These suggestions are offered merely to show the nature of the processes which may underlie the formation of a folded fundus in man and its rarity in other species.

DISCUSSION

Perhaps the most striking observation is the frequency with which folding of the fundus seems to occur—6 cases in 165 individuals—an incidence of about 3.66 per cent. Nuboer[20] found 3 cases of "Fundusknickung" in 75 autopsies, an incidence of 4 per cent. It would be interesting to know whether this ratio would hold in a larger number of cases of otherwise normal gallbladders and to what extent the presumably commoner serosal type exceeds the retroserosal type. It is hoped that the specimens now being collected from routine autopsies by the Department of Pathology may supply the needed information.* In any event, they are sufficiently numerous to raise the question as to whether much of the clinical importance attached to the presence of a kinked gallbladder may not have been based upon a deceptive coincidence of painful symptoms and a common anomaly; much, for instance, as high thymus weight is being discredited as the cause of sudden deaths, it having been shown that there is no significant difference in weight between the weight of thymuses of normal children and those dying from so-called "status thymicolymphaticus" (Boyd[7]).

But aside from this point I find it difficult to acquiesce in the reasons advanced by Bronner for attributing obscure gallbladder symptoms to a folded fundus. The contention is that the latter interferes with emptying of the viscus, yet, paradoxically enough, the very speed with which it empties (one of his cases discharging two-thirds of its contents in the usual period of forty minutes) is held responsible for the assumed trauma and consequent pains. But how could it empty at the normal rate if the obstruction was considerable? Obviously, such theories do not consider the fact that the neck of the human gallbladder is usually bent just as sharply upon itself as any congenital case of "phrygische Mütze" (the two limbs even being enclosed in a common peritoneal envelope), and as if this were not enough, nature has set up valves to further impede the flow, lest, perhaps, too much concentrated bile should be poured into the duodenum at one time.* Also, this theory takes no account of such experimental evidence as that obtained from a study of Case 6 (D.W.R., Fig. 7, E) in which contraction of an hour-glass gallbladder against obstruction was sustained for fifty-two minutes without giving rise to painful symptoms. Consequently it would seem desirable to maintain a conservative attitude toward the hypothesis that a gallbladder with a congenitally folded fundus is of "indisputable clinical importance."

SUMMARY

This study represents a survey of the shape of the human gallbladder in some 200 series of cholecystograms collected during the last ten years—each series consisting of a large number of films made to test the reaction of a presumptively normal biliary vesicle to one or more forms of physiological experimentation.

Of the 165 individuals who have furnished this material, 18 per cent exhibited marked kinking of the gallbladder, either between body and infundibulum (24 cases) or between body and fundus (6 cases).

The first group, presumably arising early in development through extreme modelling of the fossa vesicae felleae, is believed to represent merely accentuation or minor variation of a normal pattern.

The second group, characterized by a fixed, folded fundus, is identified with the

* Since this article was submitted, 80 autopsy specimens have been examined. In 32 newborns, there were 3 retroserosal cases of folded fundus; in 48 adults, 1 retroserosal and 2 serosal cases—a total of 7.5 per cent.

* It may be recalled that the soonest that gallbladder bile can be aspirated from the duodenum after a meal of egg yolk is seven minutes and that the average time is twelve minutes (Boyden and Birch[11]).

"phrygische Mütze" of German pathologists, first described by Bartel in 1916. The present study indicates that it is the most common congenital anomaly of the human gallbladder.

On the basis of new embryological studies this anomaly is subdivided into two main types: the concealed or *retroserosal* type, caused by aberrant folding of the epithelial anlage of the gallbladder within the embryonic fossa vesicae felleae, and the *serosal* type, caused by aberrant folding of the fossa itself in early stages of development. In the second type the bend in the gallbladder is fixed by development of fetal ligaments, vestigial septa or constrictions of the lumen following delayed vacuolization of the solid epithelial anlage.

Finally, on the basis of physiological studies, exception is taken to the current European theory that the folded fundus of an otherwise normal gallbladder is a source of upper quadrant pain and therefore of "indisputable clinical importance."

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Vol. 33, No. 5

INTRAHEPATIC GALLBLADDER*

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THE frequent necessity for surgical intervention in the treatment of gallbladder disease makes it important for the surgeon to have a comprehensive knowledge and appreciation of the various anatomical anomalies which may occur in the biliary tract. Variations in the blood supply and the arrangement of the ducts are so common that the experienced surgeon is well prepared to handle these anomalies when discovered at operation.

Anomalies of the gallbladder occur less frequently, but they are of sufficient importance to command the attention of the surgeon and the roentgenologist. Of these anomalies, one of the most perplexing which may be encountered is the intrahepatic gallbladder. In this condition, the gallbladder is more or less imbedded in the liver substance and, in some cases, it is entirely buried, so that it cannot be seen on the external surface of the liver.

Intrahepatic gallbladder in man is the result of some error in development. Mentzer,[9] writing on this subject, states the following:

> A review of the comparative anatomy of the gallbladder and bile ducts suggests that most of the anomalous biliary structures in man represent normal arrangements in lower animals. In many animals, the gallbladder lies more or less buried in the substance of the liver. This is true of the shark, many of the reptiles, and most of the marsupials, and of the martin, stoat, weasel, ferret, masked pig of Japan, wart hog, common pig and Indian boar. Although many of these animals have multiple lobes of the liver, the gallbladder lies within the hepatic substance rather than between the lobes of the liver. It seems reasonable to suppose that the human gallbladder, when found intrahepatically, has reverted to the form normally occurring in these lower animals.

Dévé[2] expresses the opinion that the human gallbladder is intrahepatic during the developing period but becomes extrahepatic in the adult stage.

Bower,[1] discussing this subject, states:

> If the primitive liver anlagen becomes the gall bladder, the glandular portion of the liver developing around it, one has no difficulty in explaining the intrahepatic gallbladder. Deaver estimates that in infants two percent are totally intrahepatic. Under ordinary circumstances, the tension within the gall bladder gradually forces it to the surface; the hepatic cells covering it gradually disappearing.

A reason for the occurrence of intrahepatic gallbladder in man is found in the description of the embryology of the liver and gallbladder by Keith.[5] In his book on "Human Embryology and Morphology," he describes the embryology of the gallbladder and bile ducts as follows:

> The hepatic diverticulum, from which the liver buds arise, may be regarded as a direct extension of the wall of the foregut. From its hinder part, are developed the common bile duct, the gall bladder, and the cystic duct, formed at the junction of the gall bladder and common bile duct. The hepatic ducts arise within the stalks of the solid hepatic buds. At first, the gall bladder lies in the ventral mesentery (gastrohepatic omentum); a position which is permanent in some vertebrates and may occur as a rare anomaly in man. In the second month, it becomes included and buried in the hepatic tissue; at a later date, it assumes its superficial position. The lumen of the ducts is occluded by an epithelial proliferation until the third month. Occasionally, the bud for the gall bladder divides, giving rise to a bifid or double gall bladder.

If the gallbladder is buried in the liver, in the course of normal development, there is no doubt that, in some instances, this condition may persist in adult life. This anomaly has received little attention in the literature. A search for information in regard to intrahepatic gallbladder reveals that

* From the Department of Roentgenology, St. Alexis Hospital, Cleveland, Ohio.

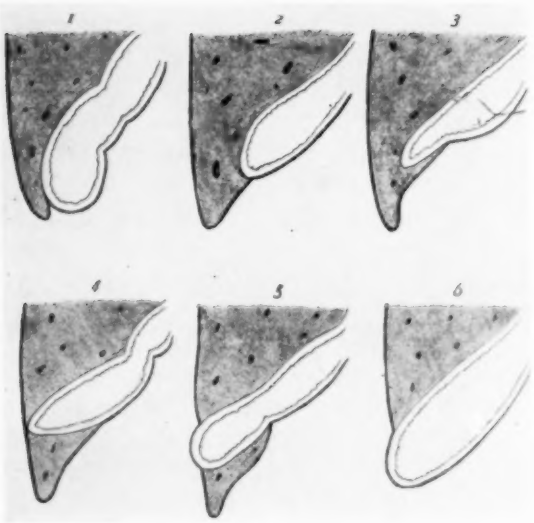

FIG. 1. Copy of Dévé's illustration taken from Wieder's article. 1. Normal disposition of the gallbladder as seen on cross-section. 2, 3, 4, and 5. Various types of intrahepatic gallbladder. 6. Resultant condition seen in adult life.

about 25 cases have been recorded so far:

Author	Year	Number of Cases	Infant	Adult	Stones
Dévé	1903	12	12	0	0
O'Day	1905	1	0	1	?
Lemon	1905	1	0	1	+
Wieder	1905	2	2	0	0
Kehr	1913	5	0	5	3
Mentzer	1924	2	0	2	?
Walter and Neiman	1931	1	0	1	+
Stetten	1933	1	0	1	+
Total		25	14	11	6

Wieder[15] states that after a careful review of the literature, in 1905, as far as the resources of the library of the College of Physicians in Philadelphia would permit, he could find no reference whatever to this condition, until reported by Dévé,[2] in 1903, before the Anatomical Society of Paris.

INCIDENCE

Dévé, in a study of 130 infants examined at autopsy, found 12 cases of intrahepatic gallbladder. In all of these cases, the fundus of the gallbladder was more or less buried in the parenchyma of the liver, but in no case was the gallbladder entirely covered by liver tissue (Fig. 1). Dévé states that this condition is found only in infants and explains that atrophy of the bridge of liver tissue covering the gallbladder occurs, due to mechanical action of the distended gallbladder pressing against the anterior abdominal wall. Wieder agrees that Dévé's contention is correct in most cases, but that this condition does persist in the adult is shown by case reports appearing since Dévé's publication.

O'Day[10] was the first in this country to report a case of intrahepatic gallbladder. He operated upon Mrs. S., on February 16, 1905, on the basis of a diagnosis of gallstones:

> Entering the peritoneal cavity, the fundus of the gall bladder was found to be transmitted through a foramen in the liver. The lower margin of the foramen was about one-half inch from the thin edge of the liver, under which edge the gall bladder is usually found. I had never seen nor heard of such a formation before.

Lemon[7] reports that Dr. W. K. Bouton, Melbourne, Australia, operated upon a patient and found no gallbladder in the usual place but found what appeared to be an hydatid cyst on the anterior surface of the right lobe of the liver. Also, a projecting eminence was found on the posterior (inferior) surface. When this was incised, bile gushed forth and two gallstones were removed. A microscopic section showed the presence of the usual structures of the gallbladder wall. Age and sex of the patient

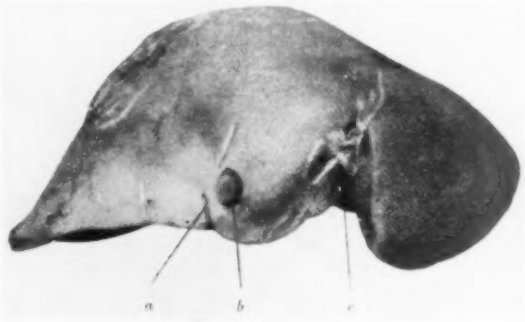

FIG. 2. Illustration taken from Wieder's article. *a*. Fissure for gallbladder. *b*. Gallbladder. *c*. Fissure for round ligament.

are not mentioned but the patient was presumably an adult.

Wieder[15] reports a case of Dr. Lowenburg:

A child, fifteen days old, died suddenly, cause unknown. Autopsy showed a patent foramen ovale and an anomalous condition of the liver and gallbladder. The fundus of the gallbladder presented 5 mm. above the free edge of the liver and appeared as a cyst (Fig. 2). Examination of the inferior surface of the liver showed that the gallbladder was deeply imbedded in the floor of the gallbladder fissure but was not covered by liver tissue. There were four anomalous fissures in the liver.

Wieder mentions another case not reported in the literature, which occurred in the practice of Hand,[3] Philadelphia:

In a child, seven years old, an anomalous condition of the gallbladder was found, similar to that reported by Wieder.

Kehr[4] states that he operated upon 4 patients with intrahepatic gallbladder and he mentions one observed by Loughran[8] at autopsy, in which a normal gallbladder was found entirely imbedded in the liver. In 3 of Kehr's cases, gallstones were found. The following abstract of these cases was included in the publication of Walter and Neiman:[13]

Case I: White, female, aged thirty-eight; symptoms of stones for six years. At operation, no gallbladder could be found and abdomen was closed. After operation, attacks of colic continued, requiring morphine for relief. A second operation was performed. Liver incised and gallbladder found to contain two stones. Uneventful recovery.

Case II: White, female, aged thirty-six. Preoperative diagnosis: Cholelithiasis. Operation: No gallbladder found. Liver incised. Gallbladder found to contain two stones. Profuse bleeding. Death occurred twelve days later.

Case III: Physician, aged forty-two. Clinical diagnosis: Gallstones. Operation: No gallbladder found. Liver incised. Gallbladder found filled with purulent material and one large stone. Patient recovered.

Mentzer[9] refers to 2 cases: one of his own and one observed by Yoell.[16] A description of these cases is not available.

Walter and Neiman[13] report the following case:

White, female, aged twenty-seven. In November, 1925, patient began to have attacks of pain in the right upper quadrant, accompanied by nausea. Attacks were intermittent. In January, 1926, there was a sudden attack of severe pain in the right upper quadrant, knife-like in character, radiating to the right scapular region. No jaundice. Operation: No gallbladder found. Abdomen explored and cause for patient's symptoms not apparent. Surgeon thought the gallbladder was absent and that a mistake in the diagnosis had been made. The edge of the liver was round and a section was removed for examination. When the liver was incised, bile gushed forth and two large ovoid stones were removed. Cystic duct not seen outside the liver. Gallbladder drained. Patient made uneventful recovery.

Stetten[12] observed the following case:

A man, aged forty-five, suffering from attacks of pain in the gallbladder region, the last one associated with jaundice. Operation: Liver presented an unusual appearance. Many fissures and lobes. The gallbladder was embedded in the liver at the end of an unusual and deep fissure. The gallbladder was removed. It contained one stone. There was one area of gangrene. Patient died two days after operation.

Two patients with intrahepatic gallbladder have been observed at St. Alexis Hospital, Cleveland, Ohio, and the record of these cases is presented here.

REPORT OF CASES

Case 1. C. K., white, female, aged forty-seven, married, no children. Admitted to St. Alexis Hospital, October 27, 1930.

Chief Complaint. Pain in right upper quadrant and beneath right scapula.

History of Present Illness. For the past six years, patient has had stomach trouble with frequent attacks of nausea and vomiting and pain in the epigastrium. Sometimes, the pain is relieved by food. For the last three years, patient has had pain in the region of the right shoulder and tip of the scapula. This pain is stabbing in character, sometimes very severe, and occurs mostly at night. Patient has been jaundiced at times. No clay-colored stools.

Past History. Had measles and influenza and an operation for an ovarian tumor; otherwise, enjoyed good health until six years ago.

Physical Examination. Well developed and well nourished woman. Some tenderness over gallbladder region. Otherwise, physical examination is negative. Blood pressure, 140/90; red blood cells, 4,200,000; white blood cells, 9,200; hemoglobin, 72 per cent. Urinalysis, negative. Temperature, pulse and respiration, normal. Liver function normal.

FIG. 3. Case 1. Fourteen hour cholecystogram. Gallbladder well visualized; above kidney.

Roentgen Examination. Roentgenogram of the gallbladder region showed no evidence of stones. The gallbladder was examined by the intravenous dye method. Fourteen hour cholecystogram (Fig. 3): The gallbladder is well visualized. It has an unusual shape and is in an unusual position. It extends outward along the lower border of the liver. The inferior aspect is concave, as though something were pressing upon it from below. It is somewhat crescent-shaped. Density is homogeneous and about normal amount. Sixteen hour cholecystogram (Fig. 4): (Two hours after fatty meal.) Decrease in size and density; shape and position unchanged. Nineteen hour cholecystogram: (Five hours after fatty meal.) The gallbladder is very faintly visualized; shape and position are unchanged.

Conclusion: Pericholecystitis with some impairment in the gallbladder function. The gallbladder empties slowly. No evidence of stones.

Examination of the gastrointestinal tract showed no evidence of intrinsic pathological process. There was moderate dilatation of the first portion of the duodenum and some six hour gastric retention.

These findings indicate that the patient has a pericholecystitis with adhesions involving the duodenum, causing some disturbance in the physiology of the stomach and duodenum.

Clinical Preoperative Diagnosis. Pericholecystitis. Duodenal adhesions.

Operation November 7, 1930, by Dr. F. P. Corrigan, who made the following notes:

The peritoneal cavity was opened through an incision a little to the right of the midline. The upper abdomen was thoroughly explored. The stomach was somewhat dilated. The duodenum was adherent; in fact, bound down to the posterior aspect of the liver and common bile duct by a heavy sheet of adhesions, which pulled the second part of the duodenum posteriorly so as to almost kink it. The gallbladder was not visible. These adhesions were separated. There was an unusually deep cleft about 2 inches from the right border of the liver, which was explored and found to contain only liver substance. The hepatic duct was lifted up with the finger in foramen of Winslow; inspected thoroughly from the point where it sprang directly out of liver substance to the duodenum. The duodenum had been attached to the duct by the strong adhesions mentioned above, which had now been freed. Incision was enlarged so as to make a thorough exploration but the gallbladder could not be visualized or palpated. There was no evidence of gallbladder in the normal location on the under surface of the liver, nor was there evidence of a scar following its removal. I concluded that either the gallbladder had been removed at a previous operation by Dr. Skeel, or that we had here an intrahepatic gallbladder which, in my opinion, would not be operable; at least, without very great risk to the patient, because the liver substance would have to be split. It was decided, therefore, after thoroughly freeing the duodenum and finding no other pathology

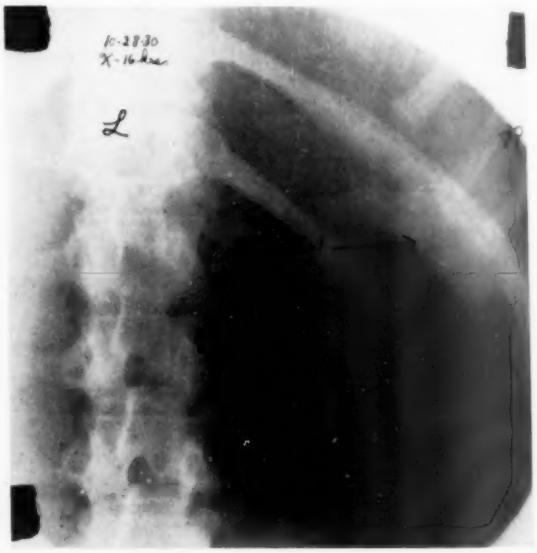

FIG. 4. Case 1. Sixteen hour cholecystogram. Two hours after fatty meal. Gallbladder decreased in size but not empty.

to conclude the operation at this point. A rather long abdominal incision was closed in layers, without difficulty.

Because of the discrepancy between the surgical and roentgenological findings, it was decided to make further roentgen examination of the gallbladder as soon as the patient's condition would permit.

Nineteen days after the operation, examination of the gallbladder by the oral dye method shows that the gallbladder in well visualized and presents the same appearance as was found in previous examination (Fig. 5). Roentgenograms were made in various positions to determine the location of the gallbladder. In all of the roentgenograms the gallbladder is located above the right kidney and above the inferior border of the liver (Figs. 6, 7 and 8). In the true lateral roentgenogram, the fundus of the gallbladder is located posteriorly at the level of the twelfth dorsal and first lumbar vertebrae (Fig. 9).

A careful analysis of this evidence shows that the gallbladder is located in the posterior portion of the right lobe of the liver, above the right kidney. The fundus is close to the posterior and lateral aspect of the liver.

The patient was discharged from the hospital three weeks after the operation. She was relieved of some of her symptoms but still complains of pain in the right scapular region.

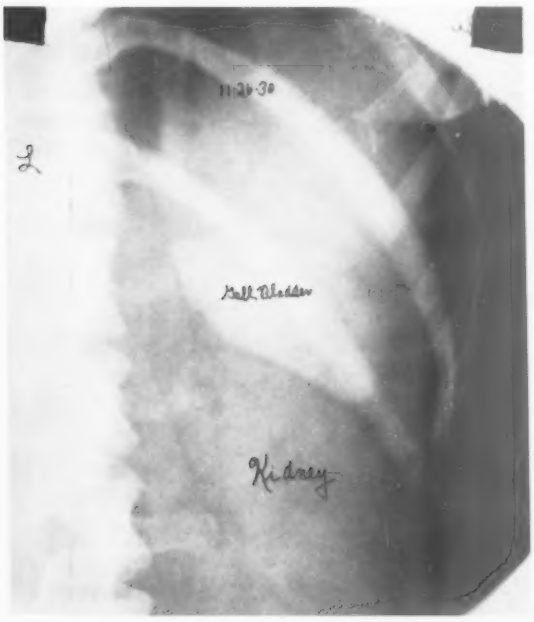

Fig. 5. Case 1. Fourteen hour cholecystogram. Made in usual posteroanterior position. Gallbladder well visualized above kidney.

Fig. 6. Case 1. Fourteen and a half hour cholecystogram. Oblique position; central ray directed from right posteriorly to left anteriorly. Gallbladder above kidney, near posterior and inferior surface of liver.

Comment. In this case, the gallbladder was well visualized by cholecystography and the surgeon was unable to find it at operation. To clear up this discrepancy, a postoperative cholecystographic study was made. The gallbladder was visualized and roentgenological localization showed it to be in the right lobe of the liver above the right kidney, with the fundus close to the posterolateral aspect of the right lobe. The long axis extends outward and posteriorly, at about a 90° angle to the long axis of a gallbladder in normal position. This unusual position has not been observed in any case of intrahepatic gallbladder reported previously. The high position and unusual appearance of the gallbladder in the cholecystogram should have suggested the possibility of intrahepatic location; but, because this anomaly was not thought of, the correct preoperative diagnosis was not made.

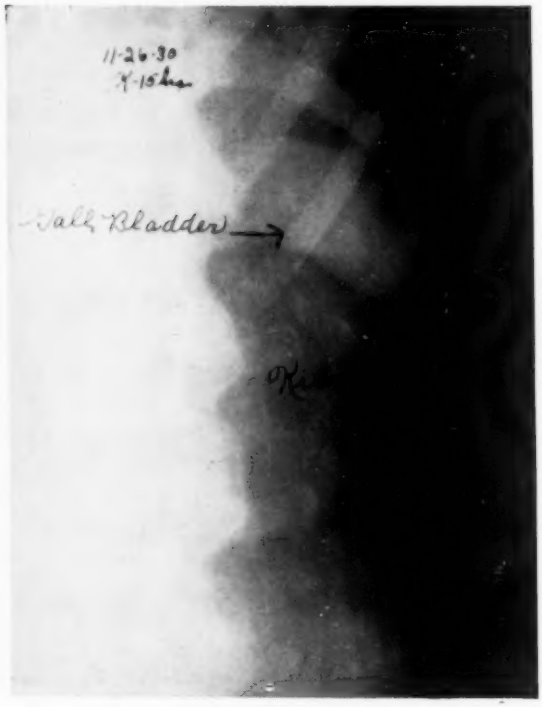

FIG. 7. Case I. Fifteen hour cholecystogram. Oblique position; central ray directed from left posteriorly to right anteriorly, patient on right side. This includes the right kidney region and posterior portion of the liver. Gallbladder is above kidney close to posterior surface of the liver.

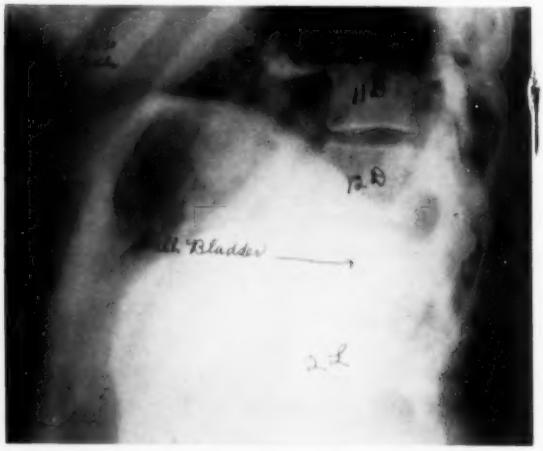

FIG. 9. Case I. Fifteen hour cholecystogram. True lateral position, patient on right side. Central ray directed from left to right. Gallbladder is visualized near the posterior surface and is overshadowed by the body of the twelfth dorsal and first lumbar vertebrae.

The fact that the position of the gallbladder has been determined should enable the surgeon to find it, without difficulty, if it becomes necessary to operate upon it.

CASE II. F. B., female, aged forty, married, 5 healthy children; entered St. Alexis Hospital March 13, 1934.

FIG. 8. Case I. Oblique position. Central ray directed from left anteriorly to right posteriorly. Gallbladder above kidney near posterior and inferior surface of the liver.

Chief Complaint. Pain in abdomen. Yellow skin. Nausea and vomiting.

History of Present Illness. Patient has been well until six months ago when she had an attack of severe pain in the right upper quadrant, radiating along the right costal margin and to the right scapular region; nausea and vomiting; no jaundice. This attack lasted one week. Except for sour stomach, she has been comfortable, until one week ago, when she had another attack of severe pain, with nausea, vomiting and jaundice. Light-colored stools and dark urine.

Physical Examination. Marked jaundice. Marked tenderness over the gallbladder area. Varicosities in both legs. Otherwise, physical examination is negative.

Preoperative Diagnosis. Chronic cholecystitis with cholelithiasis.

Operation. March 22, 1934, by Dr. E. A. Mastics. Findings of surgeon: lower border of liver rounded. Moderate amount of cirrhosis in right lobe of liver, especially in the gallbladder region. The fundus of the gallbladder extended up into the liver and presented on the superior

surface, about 2 inches above the lower border. At least one-third of the gallbladder was buried in the liver. The wall of the gallbladder was thick. The gallbladder was filled with small stones. The gallbladder was removed by dissection from below upward. Dissection was carried upward, through the substance of the liver proper, to the superior surface. This left an area devoid of liver tissue, extending from the inferior to the superior surface. Iodoform gauze and rubber tissue drain were placed in the area formerly occupied by the gallbladder.

Patient made an uneventful recovery. Discharged from the hospital April 10, 1934.

Comment. In this case, the signs and symptoms were so typical of gallbladder disease that roentgen examination was not required. At operation, the surgeon found the distal third of the gallbladder buried in the liver. The fundus presented on the superior surface of the liver about 2 inches above the lower border. The gallbladder was full of small stones. These findings are similar to those in the adult patients whose case reports are recorded in the literature.

DIAGNOSIS

It is impossible to make a preoperative diagnosis of intrahepatic gallbladder by any means available at present except by roentgen examination, and cholecystography is the method of choice.

The function of an intrahepatic gallbladder is probably impaired. The gallbladder cannot empty completely and, as time goes on, the contents become thickened, a nidus is formed, and the stage is set for stone formation. This suggestion was made by Wieder and is supported by the fact that about 60 per cent of the recorded cases occurring in the adult have had gallstones. Unfortunately, many gallbladders containing stones cannot be visualized by cholecystography, so that this reduces the chances for visualization of an intrahepatic gallbladder.

If the gallbladder is visible, careful study should be made in regard to its position in relation to the liver. An intrahepatic gallbladder is higher than normal. It may be entirely overshadowed by the liver. The lower limit of the gallbladder may be on a level with or above the lower border of the liver. Any high, unusual-appearing gallbladder should suggest the possibility of an intrahepatic position. If gallstones are found in a high position and, apparently, in the liver, intrahepatic gallbladder must be considered. In either case, the exact location of the gallbladder, or stones, may be determined by utilizing the appropriate roentgenological method for localization of a foreign body. A study of roentgenograms made in the anteroposterior, lateral and oblique positions will probably suffice to make a localization sufficiently accurate for practical purposes. If the possibility of an intrahepatic gallbladder is suggested to the surgeon, he will be better prepared to meet this difficult problem.

DIFFERENTIAL DIAGNOSIS

If the gallbladder is not found in its usual position, conditions other than intrahepatic gallbladder which must be considered are: (1) extreme fibrosis and atrophy of the gallbladder; (2) gallbladder on the left side; (3) congenital absence of the gallbladder.

(1) *Extreme Fibrosis and Atrophy of the Gallbladder.* According to Walton,[14] extreme fibrosis and atrophy of the gallbladder may follow inflammation and, in some cases, the gallbladder is no larger than a pea. Full and careful dissection is required before it is made manifest as a gallbladder.

(2) *Gallbladder on the Left Side.* Walton describes a case in which the gallbladder was attached to the inferior surface of the left lobe of the liver, to the left of the falciform ligament. When viewed from the right side, the gallbladder was wholly covered by the falciform ligament; therefore, not visible from the right side. Schachner[11] was able to find 13 cases of left-sided gallbladder reported in the literature and in one of these cases, there was a gallbladder on the right side and one on the left.

(3) *Congenital Absence of the Gallbladder.* Apparently, this occurs more frequently than intrahepatic gallbladder. Bower, in

1928, collected 59 cases from the literature and reported an additional one. It is very likely that some cases considered to be instances of congenital absence of the gallbladder are, in reality, instances of intrahepatic gallbladder. The diagnosis of congenital absence of the gallbladder should neither be made nor accepted unless a thorough and careful dissection of the liver and bile ducts has failed to show any evidence of a gallbladder. At present, there is no method available by which the diagnosis of congenital absence of the gallbladder in a living patient can be established.

Cholecystography will be helpful in the differential diagnosis of these conditions only when the gallbladder is visualized. It will be useless in extreme fibrosis and atrophy and in congenital absence of the gallbladder, but it will be helpful in a case of left-sided gallbladder with sufficient concentrating function. As pointed out by Lange,[6] if the roentgenologist does not find the gallbladder in the classical position, roentgenograms of other parts of the abdomen should be made.

In the adult, the chances are that an intrahepatic gallbladder will not be visualized by cholecystography because the function will be impaired or absent, but, if it is visualized, its location should suggest the possibility of an intrahepatic position and further roentgenological examination should be made to determine the position of the gallbladder in relation to the liver.

CONCLUSIONS

1. The term "intrahepatic gallbladder" is used to designate that condition in which the gallbladder is partially, or com pletely, buried in the liver substance.

2. A reason for the occurrence of this anomaly may be deduced from a consideration of the embryology of the gallbladder as described by Keith.

3. The evidence in Case 1 indicates that a gallbladder may occupy any position in the liver.

4. Intrahepatic gallbladder probably occurs much more frequently than is indicated by the number of cases reported in the literature.

5. Intrahepatic gallbladder should not be mistaken for congenital absence of the gallbladder. If a patient has clinical evidence of gallbladder disease and the gallbladder cannot be found at operation, it is very likely buried in the liver.

6. Roentgenological examination is the only means by which the preoperative diagnosis can be made.

7. The diagnosis of this condition will be made more frequently if this anomaly is kept in mind by the surgeon and roentgenologist.

I wish to thank Dr. F. P. Corrigan and Dr. E. A. Mastics for the privilege of reporting these cases.

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THE ROENTGENOLOGIC SIGNIFICANCE OF "MILK OF CALCIUM" BILE*

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"MILK of calcium" bile is a term used in connection with deposits occasionally encountered in the gallbladder consisting almost entirely of calcium carbonate. Our interest in this subject resulted from a study of the following case:

CASE 1. B. C., white female, aged forty-two, referred from the Gastro-enterological Clinic of the Graduate Hospital for a roentgen examination of the gastrointestinal tract. The following clinical data accompanied the patient: "For the past three months the patient has complained of epigastric pain radiating around the upper left abdomen to the precordium and occasionally to the left shoulder. (Patient has hypertensive heart disease.) There is also immediate soreness in the epigastrium after eating which subsides in a few minutes. There is always discomfort in the epigastrium, particularly at night, which disturbs her sleep. The patient has a hypochlorhydria with evidence of gastritis."

A preliminary roentgenoscopic examination of the abdomen revealed a small pear-shaped shadow in the right upper quadrant. The roentgen study of the stomach, duodenum, and small intestine was essentially negative with the exception of evidence of periduodenal adhesions. Films made of the stomach and duodenum (Fig 1, *a*) showed the shadow in the right upper abdomen as observed roentgenoscopically. We were at a loss to account for this shadow. It did not have the appearance of any of the common varieties of gallstones, of a calcified gallbladder, or of lymph nodes. It was thought the patient might have received sodium tetraiodophenolphthalein for gallbladder visualization but inquiry excluded this possibility. The fact that the shadow had been seen prior to the administration of the barium meal excluded the possibility of barium having entered the biliary tract.

A re-examination of the gallbladder area one week later (Fig. 1, *b*) revealed the same shadow. To exclude the possibility of a renal stone a lateral view was made which demonstrated the shadow in the anterior part of the abdomen. Following this a cholecystographic study was made. The roentgenograms of this examination (Fig. 2) were much superior to the previous ones and for the first time there was noted a number of negative shadows incorporated in the larger homogeneous one. Also several small faint ring-like shadows were seen slightly higher in the abdomen. Our interpretation was as follows: "The cholecystogram again shows the dense shadow in the gallbladder region found at our previous examinations. While the general shape is the same as before, there is some alteration in contour to be noted in the various films. At this time there are numerous small negative shadows to be seen in the upper portion of the larger one. There are also several small rather faint ring shadows above the larger one. No change occurs after the fatty meal. In reviewing the films made at the time of the examination of the stomach there is to be seen a very definite alteration in the shape of the shadow in question. Several of the films also show the shadow extending into the cystic duct. Conclusions: It seems very likely that the present shadow in the gallbladder region represents thickened inspissated pus infiltrated with lime salts, the result of an old empyema of the gallbladder. The negative shadows are evidently small biliary calculi. The ring shadows are evidently stones in the cystic duct."

We had on several occasions seen a putty-like material removed from cases of so-called calcification of the subdeltoid bursa and from an abscess of the kidney. The roentgen appearance of these lesions very closely resembled the present gallbladder shadow. These experiences were responsible for the above interpretation.

At operation the gallbladder was small, shrunken, and densely adherent to the peritoneum. A cholecystectomy was performed. Four stones were found in the cystic duct. Upon opening the gallbladder, it was found filled with a putty-like material which could be removed intact. This was reddish-brown in color and imbedded in it were several small stones of the mixed type. Upon examination of this putty-

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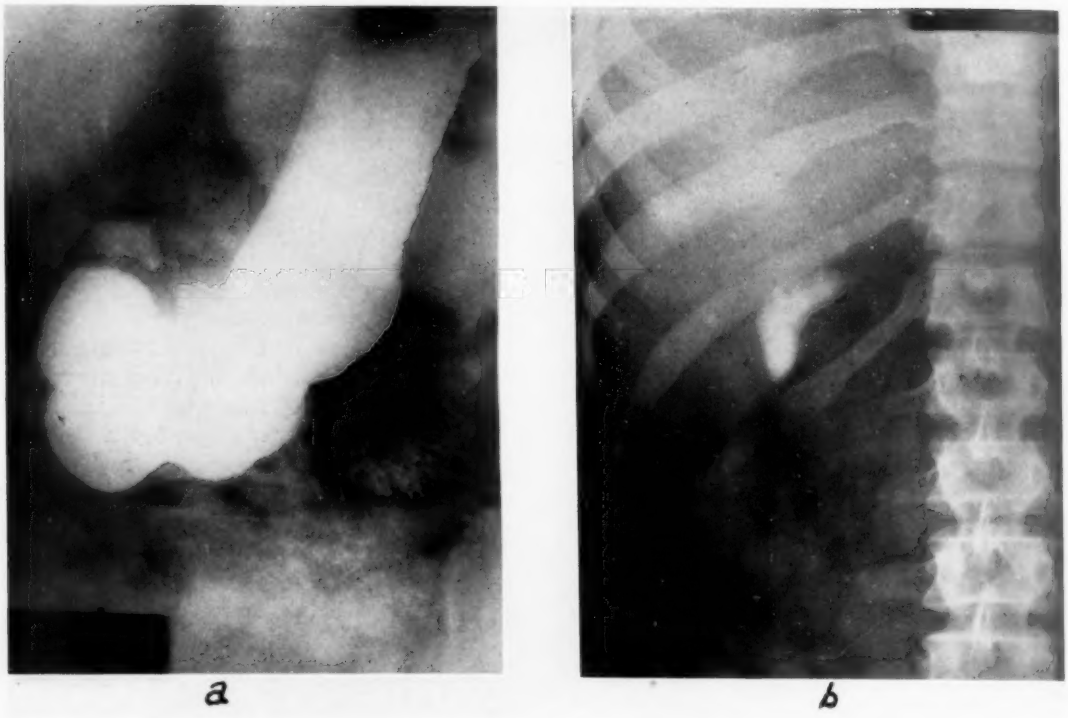

FIG. 1. Case 1. *a*. Note the faint shadow in the gallbladder region observed during a routine gastrointestinal study. *b*. The same shadow appeared in a Potter-Bucky exposure made a week later.

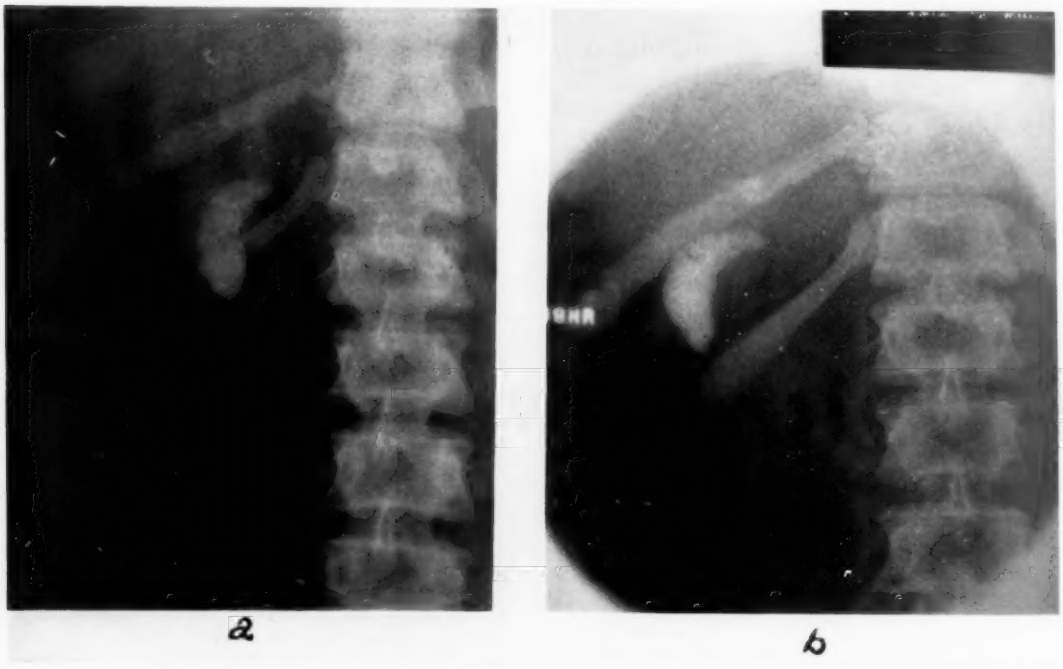

FIG. 2. Case 1. Cholecystogram. *a*. Before, *b*, after the fatty meal with practically no change in the appearance of the gallbladder shadow. Note the numerous negative shadows due to biliary calculi, also stones in the cystic duct.

like material it was found to be composed chiefly of calcium carbonate crystals. There were also some calcium bilirubin pigment and a few cholesterin crystals present. The gallbladder wall was very much thickened. Roentgenograms made of the gallbladder with its contents, of the gallbladder alone, and of the contents alone demonstrated that the shadow was cast by the material within its lumen and not by calcification of the gallbladder wall (Fig. 3).

ing for ten years of vague indigestion with a marked degree of heart burn, not related to food. She had had four attacks of right upper abdominal colic associated with nausea and vomiting, with pain radiating along the lower right rib margin to the inferior angle of the scapula. No accompanying jaundice.

The roentgen examination after the third attack of colic had subsided was reported as follows: The control exposure, as well as all those made after the oral administration of the

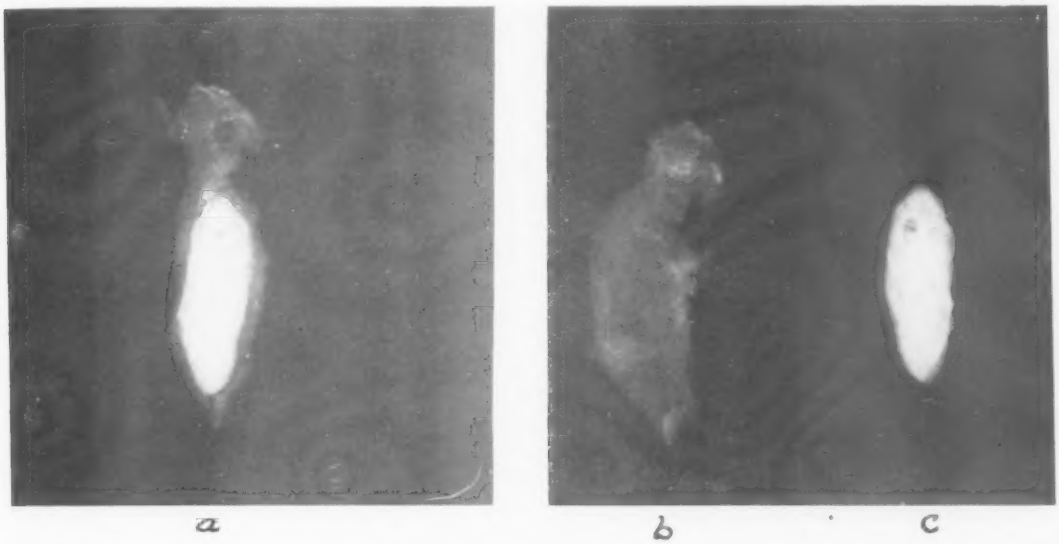

Fig. 3. Case 1. Roentgenograms showing: *a*, the intact gallbladder as removed at operation; *b*, the gallbladder after removal of its contents; *c*, the putty-like contents of the gallbladder consisting of calcium carbonate. Numerous cholesterol stones can be seen imbedded in this substance.

This experience called to mind the fact that a similar putty-like material had been found in several cases with which we were familiar at the University Hospital. We were able to find 3 of these, one from the service of Dr. I. S. Ravdin and two from the service of Dr. E. L. Eliason. Both have kindly granted us permission to report their cases. A fifth case is being reported through the courtesy of Dr. A. M. Sharpe. It is because we believe that "milk of calcium" bile can be diagnosed by the roentgen examination that we feel justified in reporting this series of cases and in emphasizing the roentgenologic aspects of this subject.

CASE REPORTS

Case II. Patient of Dr. A. M. Sharpe, Chester, Pa. A white female, aged thirty-five, complain-

dye, both before and after ingestion of fatty food, definitely show a visualized gallbladder containing dense bile and numerous small negative shadows (stones) within it. There are several small stone shadows within the cystic duct. *Inference:* Pathological gallbladder with dense bile and numerous small stones within it and several stones in the cystic duct. It is probably non-functioning (gallbladder shadow similar both before and after dye administration) (Fig. 4).

The patient was operated upon during the fourth attack of colic and made an uneventful recovery. The operation consisted of a cholecystectomy with removal of stones from the cystic duct.

Gross examination of the gallbladder showed its walls to be somewhat thickened. The lining membrane was covered with a yellowish-brown scum-like substance which was not gritty to

the finger. Within the lumen there was a small quantity of brownish fluid containing a considerable amount of this brownish material. Chemical analysis of this material was not made. Thirty-five stones were found, including those in the cystic duct.

gastrointestinal disturbances for two months. After this there was complete relief until onset of present symptoms.

Biliary drainage showed a non-functioning gallbladder.

Report of Cholecystogram: The gallbladder

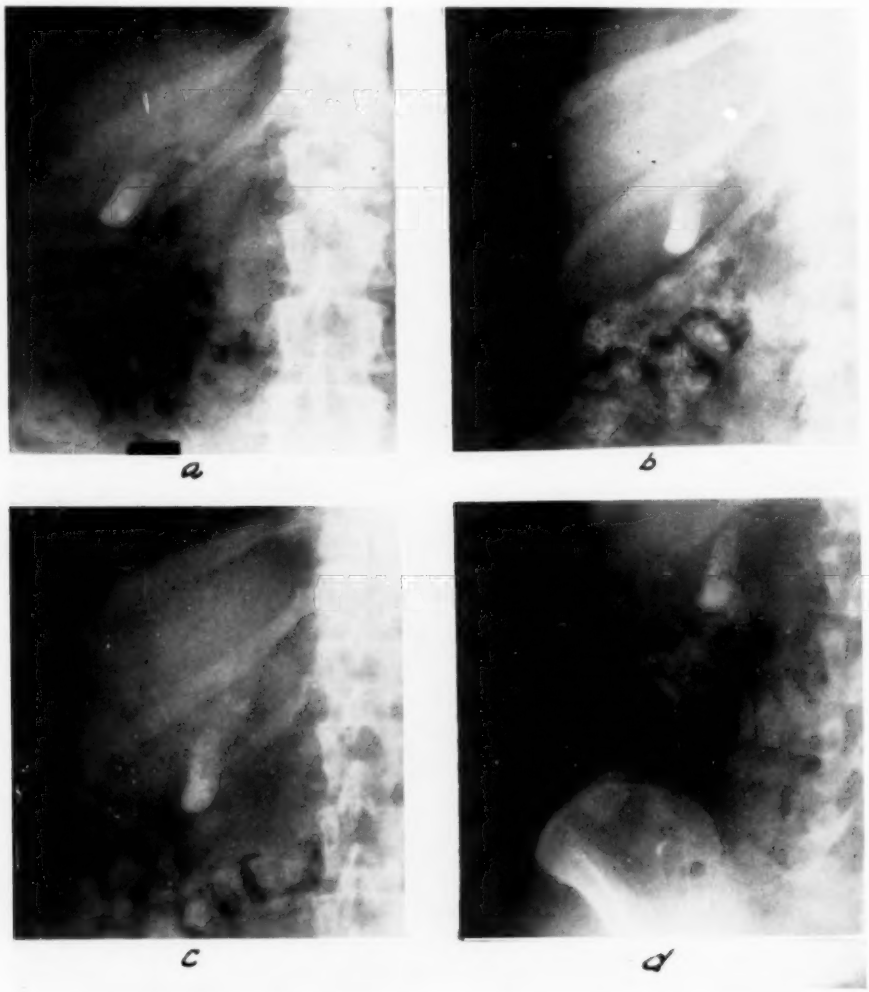

FIG. 4. Case II. *a*. Preliminary roentgenogram before cholecystography showing visualization of the gallbladder due to the presence of "milk of calcium" bile. *b*, *c*, *d*. The cholecystographic series, *b*, *c*, before, *d*, after the fatty meal. No change in the appearance of the gallbladder. Note the numerous calculi in the gallbladder and the stones occluding the cystic duct.

CASE III. F. P., white female aged fifty-five, service of Dr. I. S. Ravdin. Chief complaint of dull pain in the right upper quadrant starting six weeks before admission. Pain is worse after eating and sometimes radiates to the middle of the back. The patient had an attack of severe colicky pain in the upper right abdomen twenty years ago. This was followed by

is visualized only by the presence of gallstones, as there is no dye in the gallbladder. This may be due to faulty absorption inasmuch as the patient had three bowel movements and there is only a small amount of dye visible in the gastrointestinal tract. Diagnosis: Gallstones plus granular débris (Fig. 5).

Operation: Cholecystectomy. The gallblad-

der wall was thick; there were numerous small stones and a white pasty material which was recognized as "milk of calcium" bile.

Pathological Report: Chronic interstitial cholecystitis.

Case iv. M. M., white female, aged thirty-one, service of Dr. E. L. Eliason. Chief complaint of pain in the upper right abdomen. Illness began six years ago as a severe ache in the right upper quadrant accompanied by a feeling of distention. Has had mild attacks of indigestion since. Two and a half weeks ago was taken with a severe attack of indigestion and pain which radiated to the right shoulder and down the right arm. Tender in the right upper quadrant since then.

Report of Cholecystogram: Normally functioning gallbladder with multiple gallstones. Eighteen stones are distinctly visible (Fig. 6).

Operation: Cholecystectomy. Small distended gallbladder with thick walls containing one large soft white stone.

This large stone was found to consist of a putty-like material covering numerous small gallstones. Chemical analysis of the material was reported as pure calcium carbonate.

Pathological Report: Chronic interstitial cholecystitis. Calcium mass with gallstones.

Case v. S. S., white female, aged thirty-five, service of Dr. E. L. Eliason. Chief complaint of pain in the upper abdomen. Recurrent attacks of pain occurring five years ago, not definitely localized to the right side but radiating to the back and right scapula. Second attack three years ago since which attacks have been more frequent. Pains of moderate severity, never jaundiced.

Report of Cholecystogram: The gallbladder is visible in all of the films. It is of unusual density and shape. We are uncertain as to the proper interpretation. It shows a very small upper portion below which there is a small dense shadow. This may possibly be an indication of constriction of the midportion of the gallbladder by adhesions, a small amount of dye having reached the lower part. The upper portion shows a number of negative shadows which are evidently due to gallstones (Fig. 7).

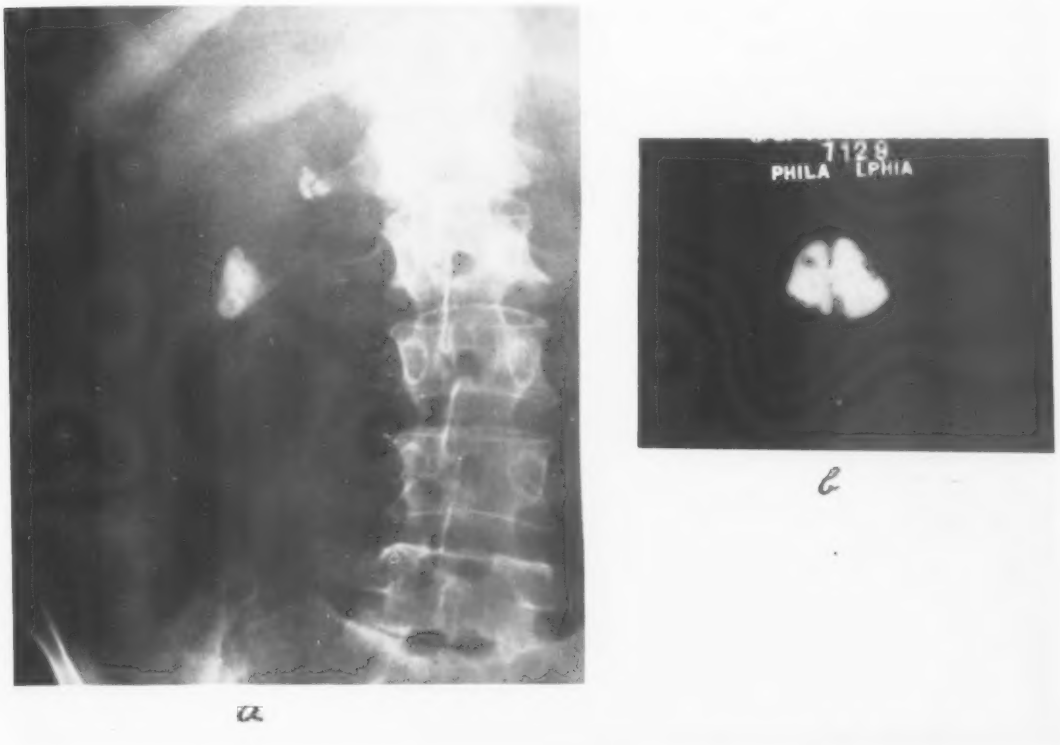

Fig. 5. Case iii. *a*. Cholecystogram showing "milk of calcium" bile and stones in the cystic duct but no visualization of the gallbladder. *b*. Roentgenogram of the material removed from the excised gallbladder

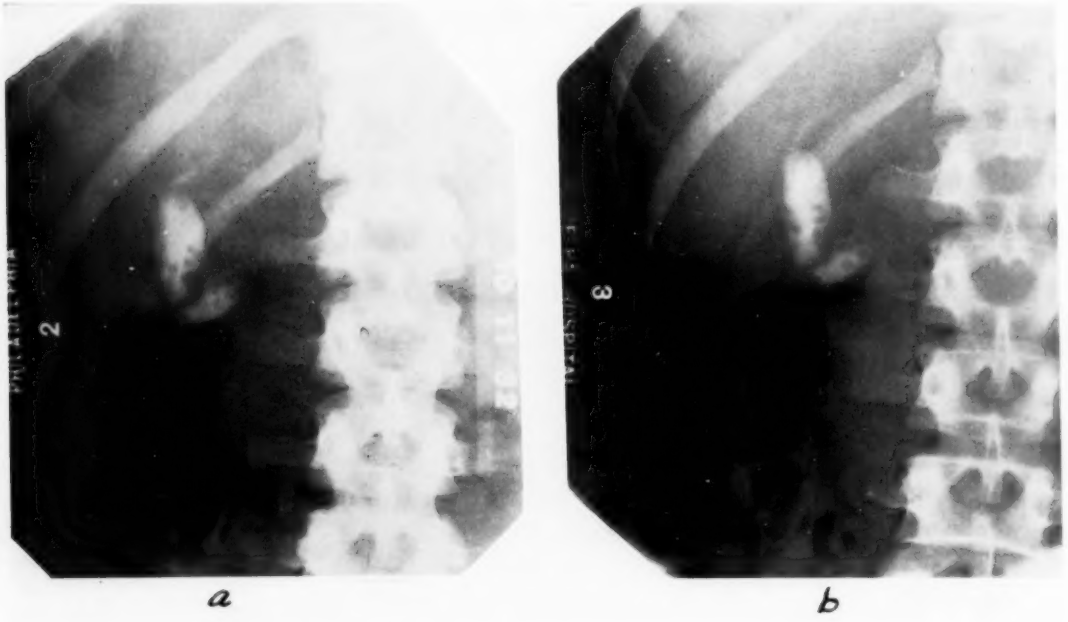

Fig. 6. Case iv. Cholecystogram, *a*, before, *b*, after the fatty meal reported as a normally functioning gallbladder with multiple gallstones. "Milk of calcium" bile mistaken for the concentrated gallbladder dye.

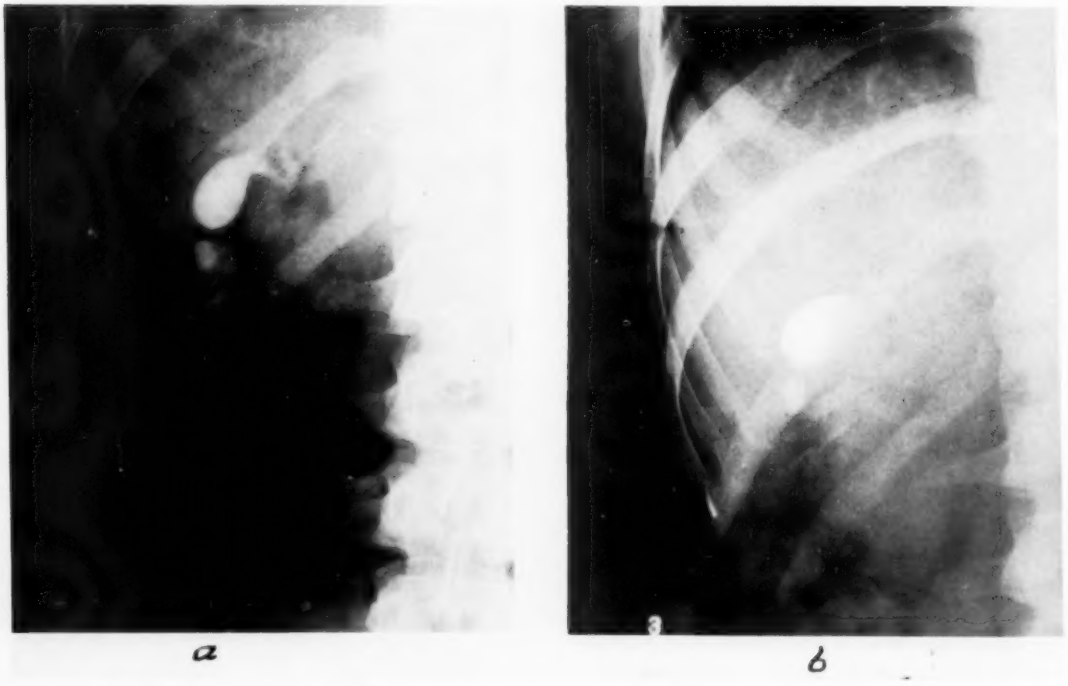

Fig. 7. Case v. Cholecystogram, *a*, before, *b*, after the fatty meal. Note the unusual density of the gallbladder shadow and the failure to change in appearance after the fatty meal.

Operation: Cholecystectomy. The gallbladder, across its center, was bound to the duodenum by dense adhesions. Stones were palpable in the gallbladder. Upon opening it a putty-like material was found in addition to the stones.

Pathological Report: A smooth-surfaced gallbladder with slightly thickened and fibrous walls. Mucosa covered with thick greenish exudate. Chronic interstitial cholecystitis.

PREVIOUS REPORTS

The occurrence of calcium carbonate deposits in the gallbladder is not at all uncommon, if we are to judge from the number of cases already reported in the literature. The earliest report was by Churchman[2] in 1911, who found a material in the gallbladder which had the consistency of tooth paste. Chemical analysis showed it to consist largely of soaps of calcium salts. No bile pigments were present but there were some free fatty acids. The cystic duct was completely occluded by stones. Churchman states that he was unable to find a similar case in the literature. The term "milk of calcium" bile (Kalkmilchgalle) apparently originated with Volkmann[18] who, in 1926, reported 2 cases in which the gallbladders removed at operation contained a white opaque fluid instead of bile. On several occasions the white fluid or putty-like material has been mistaken for barium which was thought to have entered the gallbladder during a preoperative roentgen study of the stomach (Demel and Schulze,[3] Freeman[4]). Chemical analysis subsequently identified the substance as calcium carbonate. Sasse[15] thought that the plastic, gum-like, greenish-yellow mass found in the gallbladder of the case which he reported was the dye which had been used for cholecystography. Chemical analysis, however, revealed pure calcium carbonate. Under the title of "Limy Bile" Knutsson[5] (1933) reported 12 cases showing calcium carbonate deposits in the gallbladder. Most of the articles on this subject are to be found in the foreign literature. Schubb and Goodstone[16] have recently (1933) reported a case in this country, while Phemister[8] and his coworkers have given the subject of "lime-water bile" considerable attention, reporting 8 cases.

CLINICAL AND PATHOLOGICAL ASPECTS

Clinically there is nothing to distinguish these cases from the ordinary patients with gallbladder disease. In the majority of those reported, the history was of chronic recurring and usually mild attacks of biliary colic. Not infrequently there were rather vague, indefinite abdominal symptoms. While jaundice occurred in a few cases it was not an outstanding feature. The age incidence was quite variable. From the clinical point of view the cases here reported conform in general with similar cases in the literature.

Pathologically there is to be found a marked similarity in these cases. In the vast majority of instances the gallbladder at operation was found to be small, shrunken, and contracted. In only a few was the gallbladder distended. Histological study showed evidence of an intense chronic cholecystitis with thickening of the gallbladder wall. In some instances marked fibrous tissue changes were found. The alterations in the mucous membrane lining were variable; complete loss of the mucosa was not uncommon. In addition to the calcium carbonate deposit there was usually a variable number of cholesterol or cholesterol bile pigment stones. One striking feature was the frequency with which stones were found in the cystic duct. Pathologically, the cases in this series did not differ materially from those already reported. Stones of the ordinary variety were found in all our cases and calculi in the cystic duct in 4 with no mention of their presence in the fifth case.

According to Ravdin,[11] calcium carbonate as a separate deposit may occur in the gallbladder in four different forms. It may be present as a milky fluid, as streaks of opaque material in a translucent gelatinous mass, as a putty-like or pasty material, or as a pure calcium carbonate stone. It seems conceivable that these various forms may represent transitional stages with stone formation as the terminal event. The color of the deposit will depend largely upon the presence or absence of bile. When absent,

the material is a milky or chalky-white. The presence of bile imparts to the deposit a greenish-yellow or a brownish-red color.

Pure calcium carbonate stones are among the rarest of the various types of gallstones encountered. Calcium is the constituent which renders biliary calculi opaque to the roentgen ray. The relative infrequency with which gallstones are demonstrated on plain roentgenograms indicates that calcium is seldom present in any great quantity. Much speculation has arisen regarding the mechanism by which "milk of calcium" bile originates. Most writers dealing with this aspect of the subject believe that cystic duct obstruction is an essential feature. Not all the cases reported have shown stones in the cystic duct, which, however, does not exclude obstruction by other causes, especially inflammatory changes. In a case of Whipple's reported by Phemister obstruction was due to a carcinoma. Phemister raises the interesting question as to whether or not the layers of calcium carbonate that are so often found in cholesterol or in cholesterol-pigment stones may not be deposited during periods of temporary cystic duct obstruction. He refers to the experimental work of Wilkie in which cholecystitis plus cystic duct ligation in rabbits produced stones rich in calcium carbonate, while cholecystitis without duct ligation produced cholesterol stones. In contradistinction to this is the fact mentioned by Phemister that the majority of cases of cystic duct obstruction do not show large amounts of calcium carbonate. It can thus be seen that the necessity of occlusion of the cystic duct is still an open question.

An inflammatory process in the gallbladder which usually precedes obstruction of the cystic duct is also essential to calcium carbonate deposition. According to Sasse, secondary changes in the gallbladder wall produce an exudate impregnated with lime. This author is in agreement with Volkmann that the deposition of lime-milk bile is merely a stage in stone formation; that after a time the lime is deposited around cholesterin pigment nuclei to form mixed stones. Phemister and his coworkers emphasize the importance of inflammatory changes in the gallbladder and of cystic duct occlusion. They state that the exudation into the gallbladder contains a variable quantity of mucus and are willing to accept Naunyn's[7] views that calcium carbonate is poured out with mucus from the wall of the gallbladder. They cite the fact that the only other calculi equally rich in calcium carbonate are found in the salivary and pancreatic ducts where mucus is also present. The infrequent demonstration roentgenologically of salivary and pancreatic calculi would seem to indicate that the presence of mucus may be relatively unimportant.

Whether the calcium in these cases is derived from the bile or from the gallbladder wall has been a moot question. According to Phemister, the infrequency with which bile is found in the gallbladder and the fact that he has been able to demonstrate the deposition of a rim of calcium only on the gallbladder side of the stones in the cystic duct would indicate that the calcium is derived from the gallbladder wall. Schubb and Goodstone, on the other hand, commenting upon the factors influencing the deposition of calcium in the gallbladder, state that the consensus of opinion is that calcium in the gallbladder bile is increased in the presence of inflammation; also that normal alkaline liver bile undergoes a change toward the acid side during its residence in the gallbladder. When the normal protecting acidifying function of the gallbladder is interfered with, by infection, for instance, calcium precipitation may occur. It is thus seen that there is much contradictory evidence regarding the origin and modus operandi of the deposition of "milk of calcium" bile. It must be admitted that the problem is as yet unsolved.

THE ROENTGEN EXAMINATION

We believe that the roentgen examination is the only means by which this condi-

tion may be recognized prior to operation. In most of the cases reported in which roentgenologic studies were made, the condition was either not recognized or the examination merely tended to confuse the diagnosis. To our knowledge, Phemister is the only one who has recognized the value of roentgenography in this condition. It is because of its diagnostic importance that we feel justified in emphasizing the roentgenologic aspects of the subject. The question may be raised as to the value of a preoperative knowledge of the presence of a calcium carbonate deposit in the gallbladder. The value lies in the fact that the roentgenologic findings in these cases have been the source of much confusion and have caused many unnecessary clinical investigations. Thus in several instances it was thought that barium from a gastrointestinal study had gained entrance to the gallbladder or that the dye used in cholecystography had been retained in the gallbladder in some mysterious manner. The fact that the material in many instances does not resemble gallstones may throw suspicion upon the kidney and lead to unnecessary examinations of the urinary tract. When we recall the arguments and discussions, the keen interest and the various studies conducted in order to arrive at a satisfactory interpretation of the roentgenologic findings in the first case reported in this paper, and when we take cognizance of the fact that the condition was not recognized preoperatively in the other cases of this series, then we are in a position to appreciate fully the value of some knowledge of this subject.

The procedure which offers the most certain means of detecting these cases is the routine examination of the gallbladder area prior to a cholecystographic study (Case II, Fig. 4). We doubt if many roentgenologists make a preliminary film before the administration of the gallbladder dye. The infrequency with which gallstones of any variety are found in plain films of the abdomen, the inconvenience to both the patient and the roentgenologist, and the time required for such a routine procedure makes a preliminary film impractical. Of more importance, however, is the fact that calcium carbonate deposits may usually be recognized in the ordinary cholecystogram, thus making a preliminary examination unnecessary.

In examinations of the gastrointestinal tract one should be on the alert for extraneous shadows in the abdomen. A careful preliminary roentgenoscopic examination of the abdomen and pelvis should be a part of the routine of every gastrointestinal study. The few moments required for such an examination is time well spent. It is not infrequent to find shadows in the abdomen before administration of the barium meal which become obscured or confused with the barium itself after the meal has been given. A roentgenogram made of such a shadow before the patient ingests the opaque meal will often yield information of considerable clinical importance, and will aid in the proper interpretation of the gastrointestinal roentgenograms. This procedure was of considerable value to us in the study of the first case of this series.

The most common error which is likely to occur in the interpretation of a cholecystogram in the presence of "milk of calcium" bile is to mistake the shadow produced by this material for the concentrated gallbladder dye, thus leading to the interpretation of a normally functioning gallbladder. As a matter of fact, the dye seldom gains entrance to a gallbladder containing limy bile because of obstruction in the cystic duct. Even in the absence of such obstruction the pathological changes in the gallbladder wall are such as to prevent the dye from being concentrated in sufficient quantity to produce a shadow. Since the gallbladder in most of these patients contains non-opaque calculi these will be found producing negative shadows. Such an appearance leads to the erroneous interpretation of stones in a gallbladder which has retained its ability to concentrate iodeikon. As a rule the shadow pro-

duced by a deposit of calcium carbonate is much denser than that usually seen in the normal concentration of iodeikon.

In some instances the shadows encountered in these cases are unlike anything usually found in association with the gallbladder (Case III, Fig. 5). These shadows do not have the appearance of the ordinary varieties of opaque biliary calculi. In the cholecystogram such shadows may readily be interpreted as calcified lymph nodes or renal calculi associated with a non-visualized gallbladder. When one recalls the frequency with which the gallbladder is found in regions other than its commonly accepted anatomical position, one can readily understand that irregular deposits of calcium carbonate located elsewhere than in the right upper quadrant might not be thought of in connection with the gallbladder. To guard against this error, one should determine the relationship of such shadows to the lower edge of the liver, since the gallbladder in most instances is found along the lower border of this organ. One can in most cases readily exclude the urinary tract as the site of such confusing shadows by an exposure in the lateral position wherein gallbladder shadows will almost invariably occupy an anterior position in the abdomen.

In cases of suspected "milk of calcium" bile one should search the roentgenograms for an occluding stone or stones in the cystic duct. Conversely, in cases in which stones are found in the cystic duct, one should consider the possibility of a calcium carbonate deposit within the gallbladder. The visibility of such calculi depends, of course, upon the presence of calcium as a constituent element. In 3 of the cases reported by Phemister there was a rim of calcium carbonate on the gallbladder side of the obstructing stone, producing a shadow in the roentgenograms which made it possible to detect the presence of a stone within the duct as well as to diagnose the deposition of calcium carbonate within the gallbladder. In 4 cases of our series calculi were observed in the cystic duct.

In those instances in which the calcium carbonate is in a liquid form, a change in shape of the shadow may be noted if more than one roentgenogram is made. At times the shadow will be found to extend into the cystic duct. Such observations must be made on the plain film examination since similar phenomena occur routinely in cholecystograms of the normal gallbladder. Changes in shape may be observed but to a much lesser extent in those cases in which the deposit is of a putty or paste-like consistency. In 4 of the cases reported by Knutsson[5] a definite fluid level was noted in the gallbladder after the oral administration of tetragnost in roentgenograms made in the erect position. In none of his 12 cases had the limy bile formed a true concretion. In most instances there was a light colored and hydropic bile in conjunction with the calcium carbonate deposit. This hydropic bile in contrast with the limy bile was responsible for the fluid levels found in those cases examined in the erect position. The finding of a fluid level in the gallbladder is, of course, of direct diagnostic value.

From the roentgenologic point of view, the most important clue to the presence of a calcium carbonate deposit is the constant appearance of the gallbladder shadow in the various roentgenograms of the cholecystographic study. This is especially true in the exposure made after the administration of the fatty meal. The failure of the gallbladder to reduce in size or alter its shape should make one suspicious of "milk of calcium" bile. It is not meant to imply that every gallbladder which fails to empty completely or partially after the fatty meal contains calcium carbonate, since this failure to contract is not an uncommon observation. However, under such circumstances one should observe the character of the gallbladder shadow more carefully and look for the various manifestations already referred to, especially for the presence of stones in the cystic duct and for non-opaque calculi in the gallbladder. If the case appears sufficiently suspicious, final interpretation of the chole-

cystogram should be withheld until a plain roentgenogram of the gallbladder area has been made at some subsequent time. In the presence of "milk of calcium" bile the same shadow will again be found as was present in the cholecystogram. Thus one can avoid the error of making the interpretation of a normally functioning gallbladder when in reality the gallbladder has no ability to concentrate the dye whatever. However, should the shadow of the gallbladder not persist in the subsequent roentgenograms, the presence of "milk of calcium" bile is excluded. In this connection the following case is worthy of citation:

Upon interpretation of the roentgenograms of a patient presenting clinical evidence of gallbladder disease it was noted that no change had occurred in the gallbladder shadow after the fatty meal (Fig. 8, *a*, *b*,). This brought to mind the possibility of "milk of calcium" bile. Close scrutiny of the roentgenograms revealed what appeared to be several stones in the cystic duct.

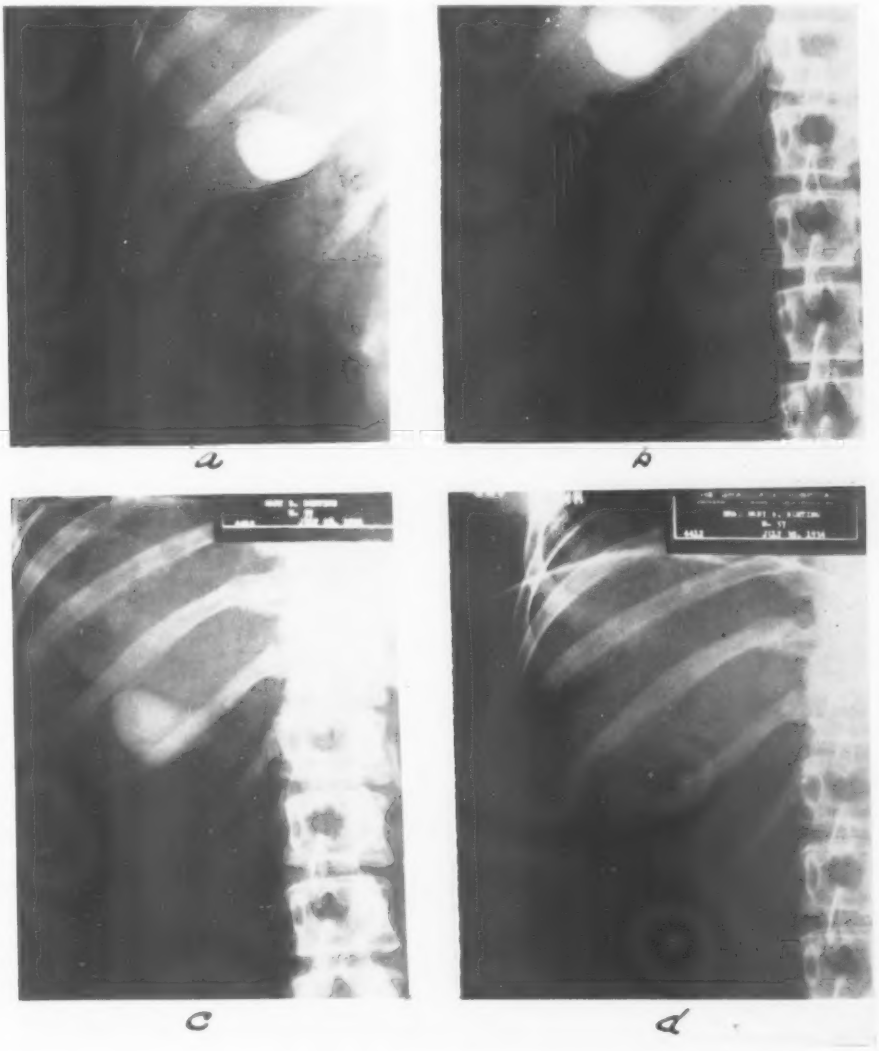

Fig. 8. Cholecystogram, *a*, before, *b*, after the fatty meal, *c*, twenty-four hours later, *d*, seventy-two hours later. The absence of change in the gallbladder shadow after the fatty meal and the continued visualization after twenty-four hours led to a tentative diagnosis of "milk of calcium" bile. Disappearance of the shadow in the roentgenogram made at seventy-two hours excluded this condition.

A plain film was made of the gallbladder area twenty-four hours after the cholecystographic study and again the gallbladder shadow was seen (Fig. 8, *c*) presenting the same appearance as it had the day before. We felt quite certain that we were dealing with another case of limy bile. The patient was again examined seventy-two hours after the original cholecystogram but at this time the gallbladder was no longer visible (Fig 8, *d*.). We then learned that the patient had had a typical attack of biliary colic the day before. It seems likely that the gallbladder emptied itself during this attack. The patient was operated upon several months later. Several small non-opaque stones were found in the gallbladder, but none in the cystic duct.

Fig. 9. The characteristic appearance of calcification of the gallbladder wall. This condition is readily differentiated from the visualized gallbladder due to the presence of "milk of calcium" bile.

While it is difficult to be certain of the factors responsible for the various phenomena presented by this case, it seems highly probable that one or more stones similar to those found at operation had entered the cystic duct after the dye had gained access to and had been concentrated by the gallbladder, that the occlusion of the cystic duct by the stones prevented emptying in response to the fatty meal, that the attack of biliary colic was the direct result of the cystic duct obstruction, and that vigorous gallbladder contractions at the time of the attack caused the stones to be dislodged and permitted the gallbladder to empty its contents. This case well illustrates the care required in arriving at the diagnosis of "milk of calcium" bile.

The shadow produced by "milk of calcium" bile must be differentiated from that seen in cases of calcification of the gallbladder wall. In the latter condition the calcium is irregularly deposited, giving a mottled appearance which can readily be distinguished from the more or less homogeneous shadow produced by limy bile (Fig. 9).

In summarizing the roentgenologic manifestations of this condition the following factors would appear to be of particular significance:

(a) Visualized gallbladder in roentgenograms without cholecystography or observed roentgenoscopically during a gastrointestinal study.

(b) No change in the appearance of the gallbladder in the cholecystogram after the fatty meal.

(c) Persistence of gallbladder shadow after cholecystography.

(d) Presence of stones in the cystic duct with a visualized gallbladder.

(e) Shadows unlike gallstones found in association with a non-visualized gallbladder during cholecystography.

Critical analysis of the above findings should lead to the roentgenologic detection of cases of "milk of calcium" bile, should prevent errors in diagnosis and eliminate the confusion so often attendant upon this condition.

SUMMARY

1. "Milk of calcium" bile is a term used in connection with deposits occasionally encountered in the gallbladder, consisting almost entirely of calcium carbonate.

2. Five cases illustrative of this condition are reported.

3. The literature is reviewed, the clinical and pathological aspects of the subject and the theories advanced for the occurrence of "milk of calcium" bile are discussed.

4. The roentgen examination is regarded as the only means by which the condition may be recognized prior to operation. A detailed consideration of the roentgenologic manifestations is presented.

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ADVANTAGES OF INTENSIFIED ORAL CHOLECYSTOGRAPHY*

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THERE are certain little-discussed shortcomings of the Graham test. As long as a fairly intense gallbladder shadow is obtained or gallstones are demonstrated the examination is considered satisfactory, but when a faint shadow is obtained or there are questionable indefinite shadows of non-calcified gallstones, especially when no shadow at all is visible, then the interpretation wavers and errors are made. Too often the roentgen report is given of a faint shadow and the final decision is left entirely to the good judgment of the clinician.

It is in such cases as these that the intensified oral method of cholecystography is of greatest value. Anyone using it will be pleasantly surprised with the added dependability and certainty of the findings and the proportion of faint shadow cases will be considerably lessened. It is a frequent experience that a faint shadow obtained at the usual fourteen or sixteen hour observation will become much more intense later on when using this new method so that the findings are no longer questionable. It is everyone's experience, regardless of the method formerly used, that there is considerable variation in the shadow intensity at the sixteen hour examination; with this new technique there is surprising uniformity of shadow opacity at forty hours and normal cases vary little, if at all. When a faint shadow is obtained at the forty hour examination it is positive evidence of definite pathological involvement and is easily recognized as abnormal. Faintly defined gallstones become much more evident, due to the greater contrast. The "no shadow" case need no longer be re-examined, as the so-called check-up re-examination has already been performed. In other words, this intensified technique gives a more satisfactory examination for the roentgenologist, the patient and the referring physician.

The intensified method was suggested to us by noting that the gallbladder shadow became more intense when starvation was continued beyond sixteen hours. In some instances the check-up on a "no shadow" case gave an intense shadow when the second dose of dye was given immediately. In addition, a reappearance of the gallbladder shadow the following morning, after apparent emptying, seemed to confirm the statements of Sandström,[5] made in 1932, when he called attention to the fact that "phenolphthalein preparations once introduced into the system circulate for a rather long time in an enterohepatic cycle. After being eliminated through the liver and its intermediary, the bile, they are re-absorbed through the intestines and so on. By introducing orally during each phase of the cycle additional small doses of the salt one may obtain a more complete absorption."

From these observations we have formulated a method which we have designated as intensified oral cholecystography.

The technique of this method is based upon three factors:

(1) Increasing and fractionating the total dose of tetraiodophenolphthalein.

(2) The free administration of sugar preceding and during the roentgen examination.

(3) The use of a fast Potter-Bucky diaphragm and an exact exposure technique.

(1) Increasing the total dose of the tetraiodo but fractionating it upon administration. The tetraiodo is given in divided doses as follows: The first dose on the evening preceding the test, the second aft-

* From the Department of Roentgenology, Lenox Hill Hospital, New York. Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

er the noon meal on the following day and the last on the evening of the same day. The amount of the dye given depends upon the weight and muscular resistance of the patient. For the average 150 pound individual 3 grams is given for the first dose and one-half that amount for the second and third doses. The total dose is approximately twice that formerly given. Sealed ampules are used, the dye being

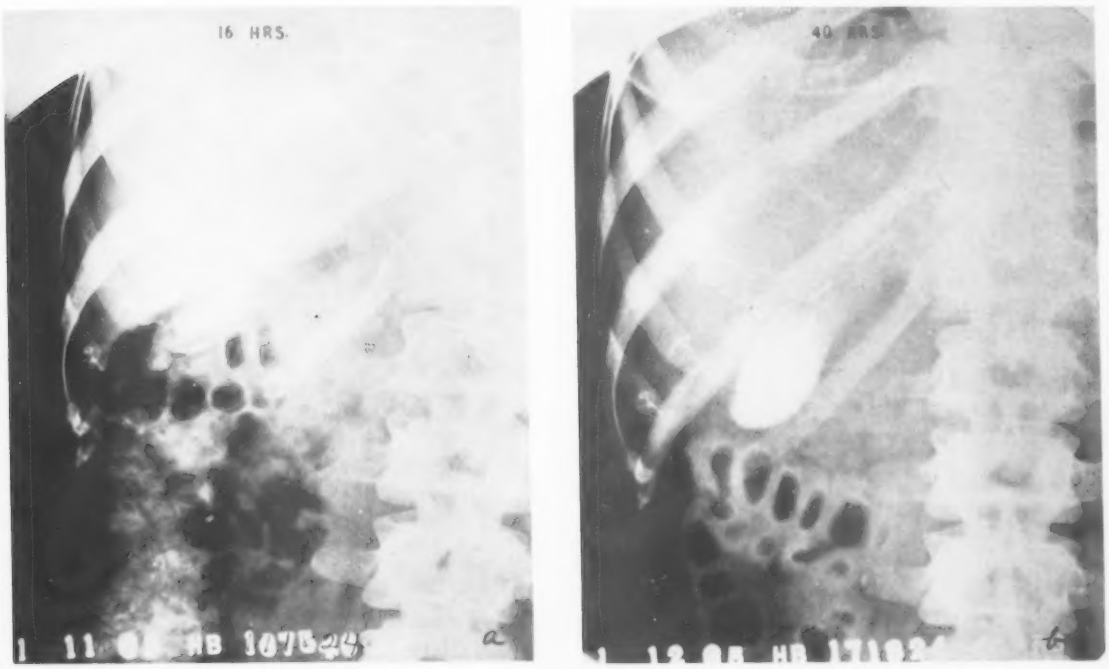

Fig. 1. Case 1. H. B. *a*. At sixteen hours the gallbladder shadow is hardly visible even though the roentgenograms are of excellent technical quality. Formerly the case might have been reported as pathological. *b*. Using the forty hour technique a normal finding results.

delivered to the patient in small bottles with each dose dissoved in an ounce of water and instructions to empty the contents into a glass of water seasoned with some fruit juice.

We have also noted that the patient is less nauseated and has less reaction when the dye is given in divided doses than with the older method.

(2) The free administration of sugar preceding and during the roentgen examination. Sugar in tea is given several times during the afternoon of the day preceding the test and again during the evening; liberal amounts are taken on the day of the test. Meals are allowed of substances which will not empty the gallbladder and which can be taken with excess sugar. Fasting is insisted upon the first morning of the test and the second morning as well.

If the importance and necessity are impressed upon the patient, he will usually readily consume a large amount of sugar but there are some patients who will not or cannot cooperate. In such cases the sugar, or better still, glucose, may be given by administration through a duodenal tube.

It may even be given by means of a rectal drip in patients who are too ill for the tube or those who are vomiting. The best results have been obtained where large amounts of sugar have been taken. Tea flavored with lemon and containing excess sugar may be taken either hot or cold. Such drinks should be freely offered on the afternoon and evening of the first day. When the dye is given, lemonade, orange-

ade, sweetened grape fruit juice or other fruit drinks containing a generous supply of sugar should be forced upon the patient as liberally as possible. It should be aimed to give at least 500 grams within the first twenty-four hours.

It may be asked "Why do we push the sugar to such an extent and what influence has it on intensifying the gallbladder shadow?" There is ample evidence that glucose from the blood stream, determining an afflux of the glycogen from the tissues if this becomes exhausted. The glycogen is then transformed into glucose which is partly utilized by the tetraiodo and partly serves to re-establish the normal glycemia level altered by the introduction of the disturbing substance. However this may be, it appears certain from researches performed so far that the glucose plays an important part in the utilization of the tetraiodo.

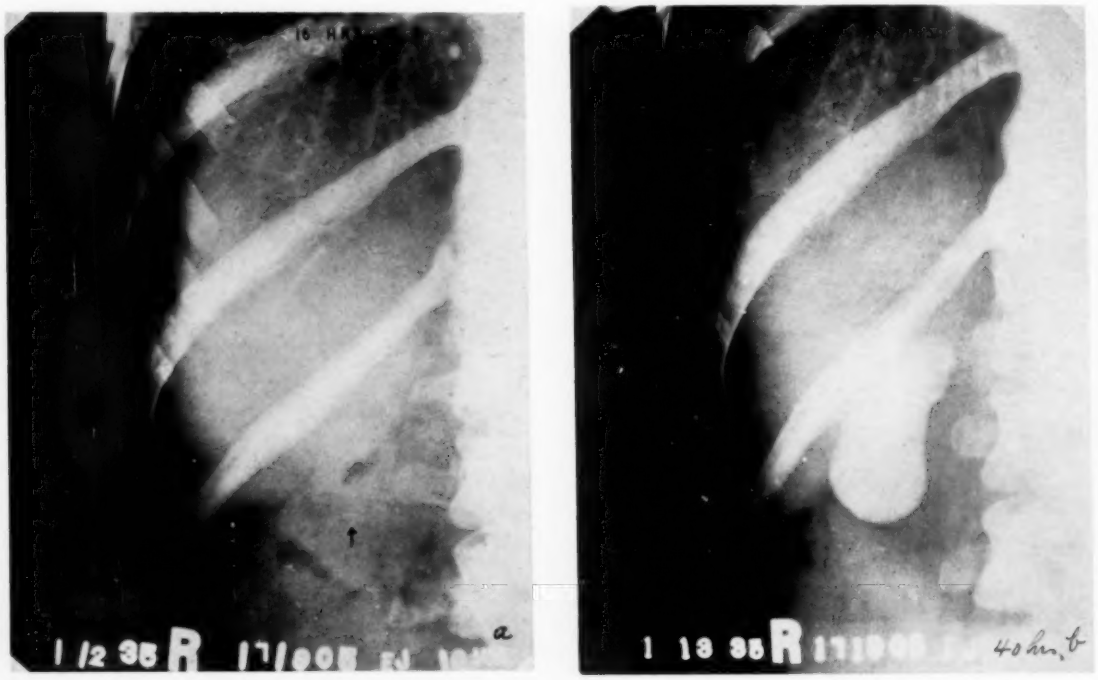

FIG. 2. Case II. E. J. In this case at sixteen hours, *a*, the shadow intensity is so slight that the observer is likely to believe the test is not properly performed. The difference is in the superiority of the forty hour, *b*, method. Skeptics will agree after trying the test. Faint shadows at forty hours are almost unknown. Faint shadows at sixteen hours and normal, brilliant intensity at forty hours are frequent findings, as experience will prove.

sugar splits up into glucose and other products and that the glucose acts as a whip for liver function including the faster and more complete absorption of the tetraiodophenolphthalein. This is confirmed by many investigators, for example, Graham,[3] and Davis and Whipple,[2] who state in substance that glucose accelerates hepatic activity.

Antonucci,[1] in 1932, reported as follows: It is the author's opinion that tetraiodo necessitates the presence of glucose, to be absorbed in the liver, and that the dye first uses the

(3) The use of the fast Potter-Bucky diaphragm and an exact exposure technique. In addition to the careful accessory technique which we have repeatedly advocated, the use of the speed Potter-Bucky has recently been introduced with which exposures may be made in as little as one-twentieth of a second. To use such speed it is necessary to have high milliamperage and corresponding elevation of the kilovoltage. At the present time we are using one-quarter second to one-half at the most with 100 milliamperes through a fairly fine

focus tube at the proper charted pre-reading voltage which will give the correct kilovoltage desired. Our distance is usually about 36 inches with an accurate centering of the tube to the Potter-Bucky. With such appliances and a patient who has been properly trained to suspend respiration, one can almost completely eliminate motion. Extending the careful supervision of the roentgenologist into the dark room is an essential which is often overlooked. Many a perfectly exposed film is ruined by carelessness in the development.

Another advantage of intensified oral technique as above outlined is that a more prolonged period of study may be made of emptying of the viscus following the usual egg yolk cream meal. Instead of emptying within an hour's time as was customary with the old technique, we now find a slower diminution in the size of the gallbladder shadow. This permits a more leisurely examination for non-calcified gallstones, adhesions and tumors. Instead of exceptionally, the ducts are frequently clearly outlined. While we do not advocate the use of the Graham test in the presence of jaundice, in not a few cases of the moderate type with a low blood sugar tolerance, administrations of sugar in large amounts apparently assisted us in obtaining a visible gallbladder using the intensified method.

Still another advantage of intensified oral cholecystography is the ability to roentgenoscope the dense shadow obtained of the gallbladder even in rather heavy patients. The new fluoroscopic screen just available greatly helps in the study of the filled or emptying viscus. General observation can be made regarding the mobility and the presence of pericholecystitis. Its relation and adherence to the duodenum may also be ascertained, localization of tenderness may be tested, the degree of ptosis may be studied, the deformity, angulation or kinking of the organ may be visualized with the patient standing or supine and by direct palpation.

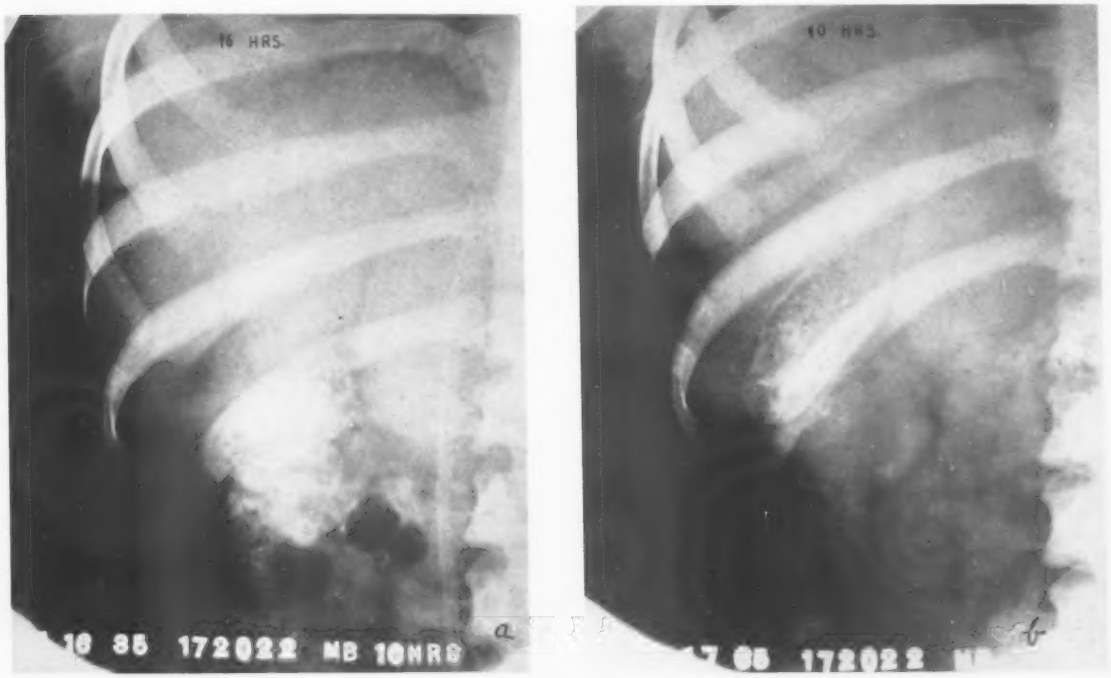

FIG. 3. Case III. M. B. Further example of indefinite findings at sixteen hours, *a*, cleared up upon forty hour, *b*, examination. Such experiences frequently gratify the surgeon, patient and roentgenologist when time is taken to use the intensified technique.

The following is a detailed account of the directions given to each patient who is to undergo a roentgen examination of the gallbladder:

First Day

One cup of clear tea with a tablespoonful of sugar at 2:00 P.M.
Repeat at 4:00 P.M.
Regular meal at 6:00 P.M.
At 7:00 P.M. take one bottle of test fluid in a glass of water with a teaspoonful of fruit syrup (3.5 grams of tetraiodophenolphthalein dissolved in 1 ounce of water).
At 10:00 P.M. take 2 cups of clear tea with a tablespoonful of sugar in each cup.
No milk or cream.

Second Day

No breakfast. No fluids.
10 to 11 A.M.: 16 hour roentgen study.

Noon Meal: (12 o'clock) Orange juice or grape fruit juice with plenty of sugar.
Fruit jello.
Fruit salad with sugar—no dressing.
1 sweet cracker.
No milk or cream.
Plain tea, coffee or water with plenty of sugar.
One hour after lunch take ½ bottle of test fluid with ½ glass of water and a teaspoonful of fruit syrup (1.75 grams of tetraiodo).

Evening Meal: (6 o'clock) Orange juice or grape fruit juice with plenty of sugar.
Fruit jello.
Fruit salad with sugar—no dressing.
1 sweet cracker.
No milk or cream.
Plain water, tea or coffee with plenty of sugar.
One hour later (7 o'clock) take ½ bottle of test fluid with ½ glass of water and a teaspoonful of fruit syrup (1.75 grams of tetraiodo).

Third Day

No breakfast. No fluids.
10 to 11 A.M.: 40 hour roentgen study.

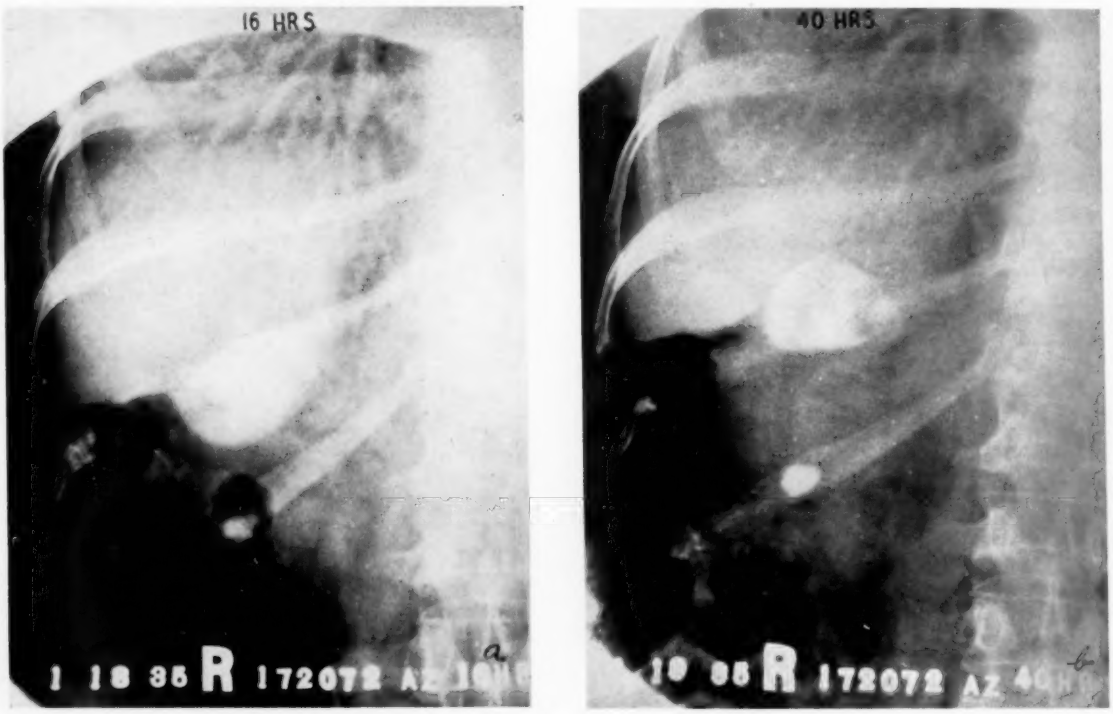

FIG. 4. Case IV. A. Z. Gallstones of cholesterin type are much better shown in the forty hour, *b*, films after intensified oral cholecystography than at sixteen hours, *a*, by the standard Graham technique. It would be difficult to recognize the calculi with certainty at sixteen hours. Operative findings: chronic cholecystitis with cholelithiasis.

12:00 noon. Lunch of eggs, milk, toast with butter, etc.

1:00 P.M.: 41 hour roentgen study for emptying power. Repeat in one, two or three hours as required.

If an immediate gastroduodenal examination is to be made do not give a solid lunch.

Rather empty the gall bladder with an egg-yolk powder such as recommended by Levyn.[4]

While we have outlined the technique of the intensified method as now used by us, investigations are constantly going on to increase the efficiency of the oral test. We believe that the additional time consumed in making this modified test is well compensated for by the accurate detailed information obtained. It is more important to find the real cause of the patient's symptoms with *certainty* than to inconvenience him less and make an incorrect diagnosis.*

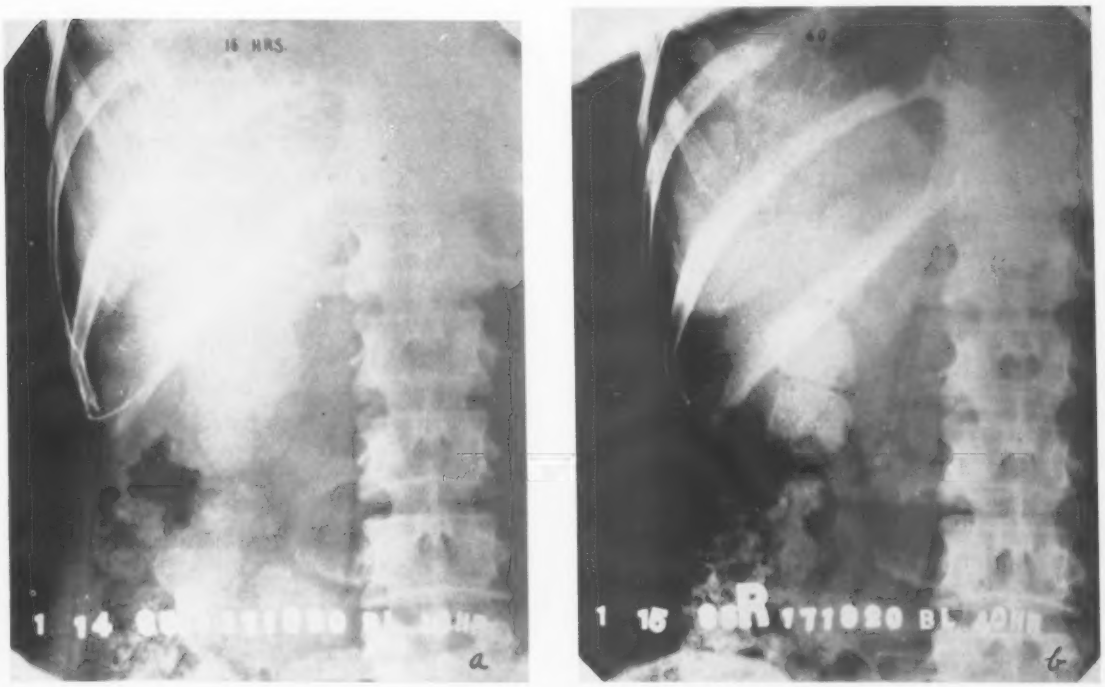

FIG. 5. Case V. B. L. It was impossible to report anything but *no shadow* at sixteen hours, *a*. The forty hour roentgenogram, *b*, demonstrates stones and gallbladder contraction, thus making an indefinite examination absolutely positive.

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* For discussion see page 633.

CHOLECYSTOGRAPHIC DIAGNOSIS OF PAPILLOMAS AND TUMORS OF THE GALLBLADDER*

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SINCE Kirklin's original presentation[3] of this subject, it is remarkable that there have been no further reports in the literature, that I have been able to find. The report of 4 cases by Kirklin[2] and 1 case by Hefke[1] in 1931, and the large series by Kirklin stimulated me to closer observation in cholecystographic examination, and emphasized the necessity of trying to get cholecystograms showing greater detail and more views at different angles.

There is little that I can add to the information in Kirklin's article, and this short presentation is given principally to stimulate other roentgenologists to search constantly for filling defects in films of normally or partially functioning gallbladders. A suspected filling defect in one cholecystogram may be a perfectly evident gallbladder tumor, when seen in a different diameter. Obviously, it is impossible to secure excellent cholecystograms in a true lateral diameter, but slightly oblique views, the angle depending on the thickness of the patient, may show the tumor and its attachment to the gallbladder wall in profile, making the diagnosis very evident. Hefke, in his report, emphasized the necessity of a tangential view of the tumor and the lack of a layer of medium between the body of the filling defect and the gallbladder wall. Only in this way can we be certain we are not seeing a non-opaque stone, but a tumor. Just as we miss seeing a larger percentage of ulcers situated on the anterior or posterior wall of the stomach, so we will always miss an equally large percentage of gallbladder tumors on the homologous walls of the gallbladder, because a tangential view cannot be secured, or the cholecystogram is of too poor quality to be of much value in the diagnosis.

Unfortunately, a large percentage of gallbladder disease occurs in short, stout individuals, frequently with thick, pendulous abdomens. It often taxes the technical ingenuity of the examiner to secure films of sufficient quality to rule out all possibility of any gallbladder disease, particularly small gallbladder tumors. It is essential that full cooperation of the patient be secured. Time should be spent in explaining to the patient the technical procedure and the necessity of full relaxation. A roentgen tube of sufficient capacity and a fine focal spot are necessary to reduce the time of the exposure to less than one second, and where possible, to less than one-half second, with a Potter-Bucky diaphragm. The least peristaltic motion of the stomach, duodenum, or transverse colon may distort the image sufficiently to confuse the diagnosis. The films should be developed and studied after each examination so that a suspected filling defect may be immediately re-examined in a different diameter, and if possible, with an improvement in technique. An hour later, contraction of the gallbladder, gas formation in the intestinal tract, and other factors, may eliminate the possibility of making a diagnosis of a gallbladder tumor. Frequently, cholecystograms, with the patient in the vertical or extreme Trendelenburg position, will show the difference between a non-opaque stone and a tumor. The stone may settle to the bottom of the gallbladder or change its relative position to that seen in other films.

CASE 1. This patient, aged fifty, had had indefinite digestive disturbances for several years with no history of gallstone attacks. Cholecystographic examination was done by the oral method in the usual manner. Films made twelve hours after taking the drug showed a normally functioning gallbladder, high under the liver.

* Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

No stones or filling defects were noted at this examination. The fourteen hour film showed the gallbladder still functioning normally, and no other pathology. After the usual meal of milk, eggs, and butter, films were made and there was a definite small filling defect in the fundus of the gallbladder. Additional films were made with a small cone and at a different angle, and the filling defect was plainer. On closer inspection the filling defect could be seen (Fig. 1) in the fourteen hour films, but it was not in profile. A definite roentgen diagnosis was made of a tumor, probably adenoma, possibly papilloma, and operation insisted on. Operation was done by Dr. D. L. Borden, and the gallbladder was removed in the usual manner. In the fundus was a small definite tumor (Fig. 2) as illustrated by the artist in Figure 3. The pathologist reported an adenoma with no suggestion of malignancy.

Fig. 1. Case 1. The arrow points to the small filling defect caused by the adenoma.

Fig. 2. Case 1. The adenoma in the gallbladder wall.

Case II. This was a woman, aged forty-seven, with a history of recurring attacks of gallstone colic over a period of several years and chronic indigestion. Cholecystographic examination by the oral method was done, and films were made

Fig. 3. Case 1. Artist's drawing of the adenoma.

at the end of twelve, fourteen, and seventeen hours after taking the drug. The gallbladder was functioning rather normally, but there were several filling defects of variable size. A roentgen diagnosis was made of normally functioning gallbladder containing several nonopaque cholesterin stones (Fig. 4). The gallbladder was removed surgically. Stones were

Fig. 4. Case II. The arrow points to the filling defect caused by the papilloma. The other filling defects were caused by cholesterin stones.

found. Also there was a small papilloma, about 3 mm. in size, in the middle portion of the fundus (Fig. 5). The only way this roentgenologic error could have been avoided would have been to make more films in different diameters, and obtain a view tangential to the tumor, or else to have examined the patient in the vertical or extreme Trendelenburg position, and the stones might have gravitated to the bottom. Even then there would be no assurance that one stone was not of light specific gravity and was floating in the bile.

Case III. This case was a man, aged sixty-two, with indefinite upper abdominal pain, indigestion, and loss of weight over a period of of two years. Gastrointestinal examination with a barium meal was entirely negative. Cholecystographic examination by the oral method showed a rather normally functioning gallbladder. There were several rarefied areas over the gallbladder shadow which were interpreted as gas in the intestinal tract (Fig. 6). The patient was explored surgically, and the gallbladder was removed. In the middle of the fundus a papilloma, about 2 mm. in diameter, was found. This roentgenologic error might have been avoided by obtaining films in an oblique or tangential view, or else with the patient in the vertical position when the intestinal tract would have dropped, possibly leaving the one filling defect to be interpreted as a cholesterin stone or a tumor.

The interpretation of gallbladder tumors is thoroughly possible, and the roentgenologist needs only to give individual attention to every case. Full cooperation

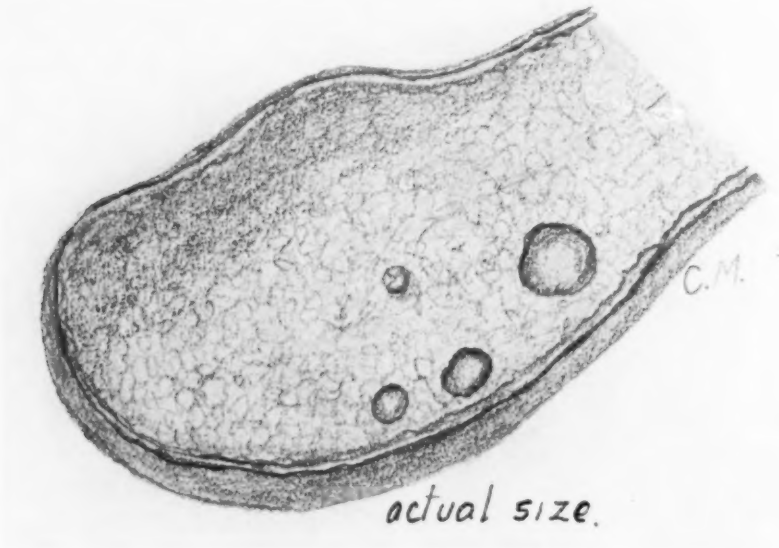

Fig. 5. Case II. Papilloma in wall of gallbladder as seen by artist.

of the patient and the office personnel is necessary. The percentage of error will decrease in proportion to the attention given to each individual case.

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DISCUSSION OF PAPERS BY STEWART AND ILLICK, AND MOORE

Dr. B. R. Kirklin, Rochester, Minn. I am always delighted to have the opportunity to discuss a paper by Dr. Stewart, especially on the subject of cholecystography. His contributions on this theme are usually timely and extremely important, and this one has been no exception. No one has contributed more to the subject of cholecystography than Drs. Stewart and Illick. The technique which they have described is another step forward, and I should like to recommend it to those who are not obtaining satisfactory results from the technique they are now employing. I should like to ask the authors what effect the intensified technique has had in increasing their accuracy of diagnosis This technique does not lessen the importance of careful roentgenographic technique, and I am inclined to believe that many of us attribute the poor results obtained by careless roentgenographic technique to the dye we are using or the method of administration. The slightest amount of movement may cause the shadow of a normal gallbladder to appear faint, or obliterate shadows of stones; a subsequent cholecystogram made without movement may disclose a shadow of normal density, or depict stone shadows that had been wiped out by movement in the previous cholecystogram. I wish to congratulate the authors on the beautiful cholecystograms that were made with this technique.

I am very grateful to Dr. Moore for his presentation of the cases with gallbladder tumors. I wish to reëmphasize the importance of meticulous technique in the recognition of gallbladder tumors. If one is on the lookout for these conditions, he should be repaid by seeing several of them, for we have found them not at all uncommon since we have been looking for them, but, as in the case of small stones, perfect technique is imperative. Papillomas are usually disclosed at any stage of the examination, while adenomas are rarely seen on the cholecystograms taken before the fat meal. It is extremely important that the cholecystograms be made before the gallbladder is completely emptied, and they should be made during the emptying phase following the fat meal.

Fig. 6. Case III. The arrow points to the filling defect caused by the papilloma. The other shadows were caused by gas in the intestinal tract.

Dr. Lester Levyn, Buffalo, N. Y. After reading Drs. Stewart and Illick's preliminary report on the intensified oral method, which was published in the July issue of the *American Journal of Digestive Diseases and*

Nutrition, I was somewhat skeptical as to the advantages claimed by the writers. We have all obtained excellent shadows following a single dose of 4 grams of tetraiodo. Not infrequently the patient vomits shortly after taking the dye, yet despite the loss of a considerable amount, shadows of very good intensity result.

On the other hand, in many instances, a single dose is inadequate to produce a shadow. I wonder how often surgery is advised because faintness or absence of a gallbladder shadow is reported by the roentgenologist following a single test. I wonder, too, how often the roentgenologist feels fortified in his opinion because repetition of the examination several days later results in similar findings. After a few unpleasant experiences, we altered our procedure by giving a second dose on the same day to patients with gallbladders which failed to visualize, and frequently obtained cholecystograms of a most satisfactory intensity. In a word, two doses at intervals of several days may be ineffective, whereas if given within twenty-four hours clear visualization occurs.

I was somewhat intrigued, however, by Dr. Stewart's preliminary report but felt that three doses, as recommended by him, seemed like a pretty big order, especially for the patients. Those of you who have taken the dye in liquid form will bear me out in this statement. However, we decided to try this new method. Incidentally, the preliminary report suggested that three doses be given, but the amount of the dye in each was not specified. It was, therefore, natural to assume that the writers had in mind the average dose of from 3.5 to 4 grams. We considered that pretty high, though, and gave 3 grams for the first and 2 grams for the second and third doses, respectively, otherwise carrying out the same routine as to the time factors and pushing the sugar. Our total dosage exceeds by 1 gram that which Dr. Stewart advocates. Our results were most gratifying, so much so that it is now a routine procedure with us whenever possible. The gallbladder shadows are consistently and uniformly superior to those obtained by previous methods, as Dr. Stewart has so beautifully shown in his slides. The intensity of the shadow lends itself admirably, as he stated, to fluoroscopic study which will not alone add to the diagnostic value of this test but may throw further light on gallbladder function.

It may be argued that the marked increase in density may obscure a stone shadow. This occurs on rare occasions, but the stones are nicely seen when the gallbladder is contracted and reduced in size.

Although originally suggesting the administration of the dye in solution in 1927, we have largely discontinued that method during the past two years. In its place we use elastic capsules, similar to those in which castor oil is marketed. Each capsule contains 1 gram of tetraiodo in emulsion. The cholecystograms are comparable in intensity to those secured when the dye is given in solution. The advantage of these capsules is that they are absolutely tasteless and patients do not rebel against them as they do against the usual purple drink. This appears to be an even more important factor with the increased dosage of the intensified method.

Sugar given in large amounts not only assists in the more complete absorption of the dye, as Dr. Stewart indicated, but equally, if not more important is the fact that glucose, into which sugar is converted, enhances the protective function of the liver.

I was pleased to hear Dr. Cannon in his classic Caldwell Lecture on Tuesday night discuss the emptying time of the stomach. You will recall he stated that fats leave the stomach much more slowly than protein and carbohydrates, the fats being retained from seven to eight and one-half hours. This, of course, has been known for many years through the work of Cannon and other physiologists. We do not use the usual egg yolk-cream meal referred to by the essayist, but instead 15 to 30 c.c., of a mixture of egg yolk, lecithin, glycerine and alcohol. This preparation induces gallbladder contraction but does not retard gastric motility as does the fat.

At the conclusion of the cholecystographic examination, therefore, the barium series may be instituted without fear of a large physiological retention when patients return for the six-hour observation, and which invariably occurs. Obviously, such circumstances may prove misleading, particularly if there be an organic lesion of the stomach or duodenum.

Like Dr. Moore, I am able to add but little to what Dr. Kirklin has discussed in his splendid article on gallbladder neoplasms in the Journal of our Society for January, 1933. Dr. Moore stated the importance of surgical cholecystograms of greater detail in order that filling defects might be more readily recognized. He also emphasized the necessity of projections

at various angles, particularly the tangential view. I believe you will be greatly helped in this respect by using the intensified method. I have seen but 2 cases in my practice verified by surgery, one a papilloma, the other an adenoma. Dr. Kirklin saw the films while in Buffalo last year.

The question was raised a moment ago about what foods are allowed during these examinations. What foods, in other words, will not have a tendency to produce gallbladder contraction. I don't think we know today just what foods are going to act in that capacity. I mention that by reason of the fact that during the past year we have been doing some work with the various types of foods, with special reference to the response of the gallbladder to these various foods, and we were very much surprised in several instances to find that certain of the solid carbohydrate foods produced a marked contraction of the gallbladder. I hope that at some future time we will have the opportunity of bringing this work to the attention of the Society.

Dr. Stewart (closing). With reference to the accuracy of diagnosis in intensified oral cholecystography, we hope to be able to give some definite statistics at some future date. Up to the present time we have examined about 150 cases with our new method. In none, so far as we know, has a mistake in diagnosis been made. That there are cases of chronic cholecystitis which give a normal cholecystographic response there can be no question. Fortunately, they are very rare.

It is strange that with all our care in making cholecystographic examinations we rarely come in contact with a recognizable tumor of the gallbladder. Three or 4 cases of papilloma would I believe, cover our experience. Even when detected we wonder of how much clinical significance they are. Dr. Eusterman of the Mayo Clinic questions their importance while Dr. Timothy Leary of Boston feels that they may be potentially the starting point of cancer.

In answer to Dr. Levyn, I would say that we have discontinued the use of capsules for some time, the main reason being that particles of the dye retained in sections of the capsules before absorption led to misleading shadows.

Dr. Moore (closing). There are no doubt some of you in the audience, who, like myself do not have national or international reputations, compared to some of these other prominent roentgenologists discussing the question. We have difficulty with men who send us cases who feel that they are going to put in their own x-ray apparatus, make the films and operate on the patients, because the diagnosis is so easily seen on the film. If you will look for gallbladder tumors and show a few of them, small papillomas or adenomas, a few millimeters in size then they will have a great deal more respect for opinions you send them in the future and will send you more cases for examination. I don't doubt in the first case I showed you, that if the gallbladder had been perfectly normal when they took it out, I might have had to leave Washington.

THE TREATMENT OF PULMONARY CAVITIES*

By LOUIS H. FALES, M.D., F.A.C.P., *and* E. A. BEAUDET, M.D.
LIVERMORE, CALIFORNIA

IT HAS been said that the treatment of pulmonary tuberculosis consists mainly of the treatment of cavities. This statement is only partially true. A statistical study of the patients in this hospital made some time ago showed that of 296 tuberculous patients, 114, or 38 per cent, had cavities. It is noted, however, that others have reported higher percentages.

Some years ago we were much surprised at the pessimistic attitude found in the literature as to the healing of cavities. We refer especially to Graeff's spectacular statement made in 1921 that the tuberculous cavity was the death warrant of the bearer. Also, statistics by Barnes and Barnes[2] that 90 per cent of 1,544 patients with cavities were dead in five years seemed equally depressing.

As our experience did not warrant this view, we have during the last few years, studied two series of cavity cases in relation to their treatment by bed rest. Cases having undergone some mechanical procedure were not included.

It should be stated that nearly all our patients are World War veterans, with a few Spanish-American veterans. One patient in our series was under thirty and one above fifty, the average age being thirty-nine.

In the first series of cavity cases studied, 147 cavities were considered. The results were published in 1931.[7] Of the 147 cavities, 42 per cent healed. Of the small cavities (2.5 cm. in diameter or less), 66 per cent healed, while of cavities larger than the specified dimensions, 23 per cent healed. It was also found that healing depended greatly on the amount of the accompanying involvement. When there was a minimal amount of involvement 66 per cent healed, while only 30 per cent healed when it was extensive.

More recently a second series has been studied, but from a somewhat different standpoint, viz., the cavities were studied in relation to their age, the type of lesions present and the progress of the lesion.

As a preliminary to the work, it was necessary that we adopt a classification for cavities, a classification based especially on their age, as one of our aims was to investigate the healing of cavities in relation to their age. Various classifications were considered, but none seemed suitable for our purpose. With our object in mind, further study of cavities brought to our attention that each pathological entity seemed to have its characteristic cavity.

For example, an exudative lesion was always accompanied by a cavity which appeared roentgenographically in the beginning as an area of diminished density, with no surrounding wall, in a soft homogeneous area of density. Its outline might be irregular, but as liquefaction and expulsion continued, a circular line of demarcation began to appear, marking out the borders of the developing cavity. The area of diminished density would soon take on a round or oval appearance, and as the exudate became absorbed and fibrous tissue developed in the line of demarcation, a circular shadow with a thin soft wall would appear.

In a productive lesion, the accompanying cavity also had its special characteristics. It appeared roentgenographically as a circular or oval area of diminished density surrounded by a rather thin wall of medium hardness. By the time a cavity reached this stage all exudate had disappeared and the tuberculous involvement, if present, was productive in character.

In the fibrotic lesion, the characteristics of an accompanying cavity had again changed. This was a still later development

* From Veteran's Administration Facility, Livermore, California. Read before the Veteran's Administration Facility Medical Society, Livermore, Calif., March 14, 1934.

and appeared roentgenographically as a more or less circular or irregular area of density surrounded by a wall which was usually thick and appeared dense and hard. The surrounding infiltration appeared fibrotic in type, with band-like and linear markings, stellate shadows, irregular areas of density, etc.

It therefore occurred to us to classify cavities as exudative, productive and fibrotic, each having distinctive characteristics, with the age of each type corresponding to the age of the lesion.

This classification had its advantage in that it drew a sharp distinction between the different age groups of cavities, allowing us to study quite accurately the response to rest of each group. The classification also has a pathological basis and fits in nicely with the newer concepts of tuberculosis: That adult tuberculosis frequently begins as an exudative infiltrate in a hypersensitive individual, where the exudate may be rapidly absorbed, leaving no trace, or caseation, liquefaction and expulsion may follow with cavity formation. The individual becoming less hypersensitive, the infiltrate being mostly absorbed, the areas of infiltration take on a new aspect. Instead of an exudate, the production of tubercles takes place with but slight inflammation. Fibrous tissue begins to be produced, forming a wall around the cavity and becoming a part of each integral lesion. Later, hypersensitiveness becomes still less, fibrosis begins to predominate, and the well-known fibrous type of tuberculosis, with its contraction and deformities, is produced, the cavity also being subject to these changes.

THE SECOND SERIES OF CAVITY CASES

The second series of cavities comprised 90 which were found available for study, after discarding those that had been subjected to surgery, a number who had been in the hospital less than one year,* a few terminal cases, and a few that had developed pleurisy with effusion which obstructed all view of the lung markings.

Great care was taken in the diagnosis of cavities. When in doubt, frequent serial roentgenograms were taken. Positive sputum was considered as suggestive evidence that cavity existed, although in many cases having positive sputum no cavity could be found. In this series of cavity cases, 86 per cent had positive sputum. Those that had negative sputum were examined with special care before a definite diagnosis of cavity was made.

A cavity was considered healed when the annular shadow or area of diminished density had disappeared or was replaced by a stellate shadow or irregular area of density. In the cavities considered healed, 12 per cent still had positive sputum. After a careful study of these cases it was considered that all of these 12 per cent had other areas of pulmonary infiltration, which probably accounted for the positive sputum.

It has been stated that although cavities may close by rest, a true healing does not always take place and a large percentage reopen. In this series 75 per cent were observed from six months to five years after the cavities had healed. In none of these did the cavities reopen. Of the 25 per cent observed less than six months, 2 reopened. These accidents occurred after one patient had persisted in frequent visits to his home, and after the other had gone on a four days' leave and had returned in a half intoxicated condition.

ANALYSIS OF CAVITY STUDY

Attention is called to Table 1, which is a fairly comprehensive study of the healing of cavities of our series from several aspects:

Of the 90 cavities of the series, 29 were classified as exudative, 49 as productive and 12 as fibrotic.

The cavities varied in size from 1.5 to 6 or 8 cm. in diameter. Many that healed were large, one being 4.5×8 cm.

* Less than one year was considered hardly a fair trial for the healing of cavities by rest. An unhealed cavity case, therefore, was not added to our list until it had been under observation for one year.

As to the shape of the exudative cavities, 93 per cent were round or oval; of the productive, 80 per cent; and of the fibrotic, 50 per cent.

The walls of the cavities were classified under three heads: absence of walls, thin walls and thick walls. Approximately 24 per cent of the exudative cavities had no walls, or an almost undiscernible thin line of demarcation; 55 per cent had thin walls and 21 per cent thick walls.* Of the productive cavities, 40 had thick walls and the remainder thin walls. Eighty per cent of the fibrotic cavities were classified as having thick walls.

The percentages of cavities that healed seemed very significant. Of the 29 exudative cavities, 19 healed, or 66 per cent; of the 49 productive cavities, 21 healed, or 43 per cent; but of the twelve fibrotic cavities, only 2 healed, or 17 per cent.

The length of time required for the healing of cavities was as follows:

Of the 19 exudative cavities that healed, 11, or 58 per cent, healed in six months; 7, or 37 per cent, in from six to twelve months, a total of 18, or 95 per cent, within one year.

Of the 21 productive cavities that healed, 3, or 14 per cent, healed within six months; 11, or 52 per cent, in from six to twelve months, a total of 14, or 66 per cent, within one year.

Table 1 also shows that the healing of cavities ran more or less parallel to the retrogression or progression of the accompanying lesion; also that there were many in which the cavities became smaller, many of which have since healed.

TABLE I

Classification	Number of Cavities Considered	TYPE OF CAVITIES: Shape: Round	Shape: Irregular	Walls: No walls	Walls: Thin	Walls: Thick	CHANGES IN THE CAVITIES: Healed: Number	Healed: Per Cent	Healed: Course of Lesion: Retrogressive	Healed: Course of Lesion: Progressive	Healed: Course of Lesion: Stationary	Smaller: Number	Smaller: Per Cent	Smaller: Course of Lesion: Retrogressive	Smaller: Course of Lesion: Progressive	Smaller: Course of Lesion: Stationary	Larger: Number	Larger: Per Cent	Larger: Course of Lesion: Retrogressive	Larger: Course of Lesion: Progressive	Larger: Course of Lesion: Stationary	No change: Number	No change: Per Cent	No change: Course of Lesion: Retrogressive	No change: Course of Lesion: Progressive	No change: Course of Lesion: Stationary	TIME OF HEALING: Six Months	Six Months: Per Cent	Six Months to Twelve Months	Six Months to Twelve Months: Per Cent	Over One Year	Over One Year: Per Cent
Exudative	29	27	2	7	16	6	19	66	19	0	0	6	20	6	0	0	4	14	3	1	0	0	0	0	0	0	11	58	7	37	1	5
Productive	49	39	10	0	29	20	21	43	21	0	0	10	20	8	2	0	11	23	1	9	1	7	14	3	4	0	3	14	11	52	7	34
Fibrotic	12	6	6	0	2	10	2	17	2	0	0	3	25	1	0	2	2	17	0	0	2	5	41	0	0	5	1	50	0	0	1	50
Total	90	72	18	7	47	36	42	46.2	42	0	0	19	21.1	15	2	2	17	18	4	10	3	12	14.3	3	4	5	15	36	18	43	9	21

* That some of the exudative cavities seemed to have thick walls was due to the fact that as the surrounding exudate was gradually absorbed, the last remnants were often just outside the cavity, giving it the appearance of having a thick wall.

DIFFERENT OPINIONS AS TO THE TREATMENT OF CAVITIES

There is a great diversity of opinion as to the proper treatment of cavities. The tendency seems to be to place more and more stress on mechanical means and less on conservative institutional treatment.

O'Brien[11] states that in his opinion practically every unilateral tuberculous lesion,

even without cavity, should have some compression therapy, and that almost none of them be left to bed rest.

On the other hand, Pottenger[15] stresses the frequent healing of cavities, especially the acute (our exudative) types, under the dietetic-rest regime. He states: "A pessimism prevails regarding the healing of cavities which is not warranted. They often heal spontaneously while the ordinary rest regime is being carried out, and those that do not heal may be treated successfully by mechanical aid."

Results Attained by Mechanical Means. O'Brien[12] reports 378 cavity cases operated by phrenicectomy, 191 closed, or 50.5 per cent. Of 238 cavities with thin walls, 134 closed, or 58.8 per cent. Of 84 thick-walled cavities, 6 healed, or 7.1 per cent.

Broga[3] reports results observed after nine months to two years or more after phrenicectomy: 38 cases, closed 13, or 34 per cent. These were mostly of a far advanced group, many with extensive cavitation.

Bronfin and Chernyk[4] report a series of cases in which there were a few young cavities. Of 122 cavity cases operated by phrenicectomy, 12, or 10 per cent, healed and became arrested in from six months to two years.

Hedblom and Watterson[8] report the closing of cavities in 12 out of 35, or 34 per cent, by phrenic nerve operation.

Peters,[14] in a series of cases treated by pneumothorax with complete compression reports that 53 per cent are well. When intrapleural pneumolysis was used in conjunction with pneumothorax, 57 per cent.

Results Attained by Rest. Mayer[10] reports a personal study of 22 young cavities a little over 2 cm. in diameter and surrounded by a minimal amount of disease which were treated by bed rest alone. Eleven cavities, or 50 per cent, completely disappeared, and 5 decreased in size, during a period of five months.

McMahon and Kerper,[9] in a study of 296 cases of pulmonary tuberculosis with cavity, found that spontaneous healing was inversely proportional to the size of the cavity. Closure occurred in 48 per cent of those 2×2 cm., 20 per cent of those 3×3 cm., and 15 per cent of those 4×4 cm. He does not state the time of observation.

Ornstein and Ulmar[13] discuss the treatment of acute types of pulmonary tuberculosis, many of which had cavities. They state that neither the exudative type, which corresponds to our exudative, nor the exudative productive type, which corresponds to our productive type, should be treated by mechanical means; that these lesions will heal spontaneously.

For comparison of results attained by rest with those attained by mechanical means, see Table 11.

It should be stressed, however, that in making these comparisons, we should keep in mind that practically all those who underwent surgical procedure were required to rest in bed for various lengths of time after the operation. It is difficult, therefore, to say how much of the result was due to mechanical measures and how much to rest. It is no doubt true that in the exudative cavities rest was by far the main factor in their closure. In the productive cavities rest was also a most important factor and should not be forgotten.

On what do those who favor immediate or early mechanical procedure in the treatment of pulmonary cavities base their argument?

1. That they attain much better results from early surgical procedure than can be hoped for by rest. A glance at Table 11 will refute this, especially when it is realized that mechanical means are still available for those cases in which the cavity does not respond to rest.

2. That the longer compression is postponed, the greater the danger that adhesions will develop, interfering with the introduction of air into the pleural cavity. This is only true in a small percentage of cases. New adhesions are only apt to form if there is progression of the lesion. In afebrile cases kept on strict bed rest, the lesions are usually retrogressive, there be-

ing but slight danger of spread of the disease. After several years' observation of groups of mostly afebrile, but active, cases, we have noted that the incidence of pulmonary extension was less than 20 per cent. McMahon and Kerper[9] state that collapse therapy does not eliminate the danger of spread, as shown by the fact that an early collapse had a 25 per cent incidence of spread after collapse, as compared with 24 per cent for the group as a whole, which contained many hopeless cases.

3. That the walls of cavities, as they grow older, become thicker and more fibrotic, making them more difficult to collapse and heal, even by mechanical means. It is true that the walls of many cavities, as they grow older, become thicker. This occurs especially in patients who are allowed considerable exercise. In most patients who are kept on strict bed

TABLE II

COMPARISON OF REST AND SURGERY IN HEALING OF CAVITIES

Authors	Treatment	Type of Cavities	Number of Cases	Number Healed	Per Cent	Time Required
O'BRIEN	Phrenectomy	Mixed	378	191	50.5	Not stated
		Thin walled	238	134	58.5	Not stated
		Thick walled	84	6	7.1	Not stated
BROGA		Mixed—many old	38	13	34.0	Nine months to one year
BRONFIN AND CHERNYK		Mixed—a few young	122	12	10.0	Six months to one year
HEDBLOM AND WATTERSON		Mixed—many far advanced	35	12	34.0	Not stated
PETERS	Pneumothorax	Mixed	700	Not given	53.0	Not stated
	Pneumothorax with intrapleural pneumolysis				57.0	Not stated
FALES AND BEAUDET	Rest	Exudative	29	19	66.0	95% healed within one year
		Productive	49	21	43.0	66% within one year
		Fibrotic	12	2	17.0	50% within one year
		Mixed types	90	42	46.6	Three months to two years
		Mixed types*	237	104	44.0	Three months to two years
MAYER		Young—2×2 cm.	22	11	50.0	Five months
MCMAHON AND KERPER		Mixed—2×2 cm.	Not stated		48.0	Not stated

* Total number of cases in the two series.

rest, it is quite different. The cavity walls increase in thickness very slowly. In some of the new cavities the walls appear to become thinner and almost disappear as the cavity is about to heal.

4. That the early use of surgical aid will hasten the healing of cavities, an important economic factor, allowing the patient an early return to active life. In the exudative types and in many of the productive types, a saving of time by early mechanical means is doubtful. It is quite evident that if our 66 per cent of exudative cavities which healed had been subjected to phrenicectomy, there would have been no advantage as to time, as 95 per cent healed within one year. Also, the sacrifice of diaphragmatic function in these cases would have been unjustified. Pottenger[15] recently expressed the view that no matter what method is used in the treatment of cavities, it must be borne in mind that it takes a long time to bring about a permanent healing; that cavities subjected to surgical collapse must heal like other tissues that are infected.

THE TREATMENT OF CAVITIES

What may we consider a logical working basis for the treatment of cavities?

In the first place, it is quite necessary that we distinguish the different types of cavities. The young or exudative cavity requires far different treatment from the old fibrotic types.

Based on findings stated above, it is only logical that practically all exudative cavities be placed at first on strict bed rest. If elevation of temperature, with other signs of toxemia, is present, these will require absolute or almost absolute rest in bed. Those without constitutional symptoms may be allowed to go to the toilet and later to their meals, but the rest period should be from twenty-two to twenty-four hours daily. Only after the cavities have healed should less rest be required. Experience shows that it is not advisable to place the patients on graduated exercise until the cavities are healed and the lesions absorbed, or fairly well fibrosed.

Many of the older or productive cavities will also heal by strict rest in bed, so the treatment of a majority of these should begin with rest.

By experience, we can judge to a certain extent which cavities are most likely to heal by rest, remembering the following criteria, which are especially favorable for the healing of cavities: Exudative cavities; productive cavities, with thin walls; cavities not too near the periphery and in the upper half of the lung; cavities accompanied by but little infiltration; cavities in which the lesion is retrogressing.

Although fibrotic cavities require rest also, and many are greatly benefited, it is usually necessary to resort promptly to mechanical aid if we are to expect a healing.

When patients with cavities are undergoing rest treatment, they should be under careful observation and continuous supervision. Roentgenograms should be taken at intervals of from six weeks to two months and oftener, if we have any reason to fear that a lesion is progressing or a cavity is enlarging. In a rapidly progressing case, surgical intervention should be promptly considered. One should not be unduly alarmed, however, if, during the first three or four months, the cavity does not become smaller or increases somewhat in size, provided the lesion starts to retrogress and the constitutional symptoms are slight. The cavity, when first seen, often contains necrotic débris, which must be expelled before it can begin to close.

If, after from six or eight months, the cavity shows no tendency to close, it is time to consider surgical aid. By this time, if we have given our patients sufficient rest, we may expect to find about 40 per cent of the exudative cavities already healed, nearly 30 per cent more well along toward closure and about 30 per cent remaining to be considered for surgical aid. At this time also, of the productive cavities we may expect about 45 per cent either healed or well along toward closure, leaving about 55 per cent to

consider for surgical aid. Routine sanatorium care, of which rest is the most important, is therefore a most important factor in the healing of cavities. One advantage of this treatment is that all cavity cases are suitable for rest, while only in a limited number can surgical compression be used.

When mechanical aid is deemed expedient, what type of operation should first be used? We are inclined to resort to the operation, which, being fairly simple and safe, is also the least burdensome to the patient. The cavities in question being young, thin walled, most of them with a minimum of surrounding infiltration, they may need but a little additional incentive to bring about a closure. A phrenicotomy* or a phrenicectomy may serve the purpose. The immobilization of the diaphragm with its elevation may give sufficient additional rest and decreased lung tension to obtain results. Rest, as outlined above, with the aid of phrenic nerve operation, may be expected to bring about the healing of a few more cavities than rest alone. It should increase the healing of the exudative cavities from 66 per cent to approximately 75 per cent; and of the productive cavities, from 43 per cent to about 50 per cent.

After rest and phrenic nerve operation have produced their results, about 25 per cent of the exudative cavities and 50 per cent of the productive cavities are still unhealed. Artificial pneumothorax should now be the operation of choice. Many lives have been saved and many startling results have been attained by the use of pneumothorax, but if we analyze its use carefully, we find, unfortunately, that its value in the treatment of cavities is rather limited. The consensus of opinion seems to be that an effective compression in pneumothorax can be attained only in a minority of all cases. When an effective compression is obtained and can be maintained from two to five years, a closure of a large percentage of cavities may be expected. Peters[14] reports that in his complete compression series, his results showed a healing of cavities in 57 per cent of the cases. However, according to the Report of the Committee on Treatment[16] appointed by the American Sanatorium Association, in nearly two-thirds of the cases studied it was necessary to discontinue treatment on account of the development of pleural complications, including obliterating adhesions. Also, artificial pneumothorax has its risks. Not many years ago it was reported that pleural effusion occurred in 70 per cent of cases; of these, 20 per cent developed tuberculous pus and 7 per cent empyema with mixed infection. The introduction of selective collapse and improved technique have modified the above figures, but this method of compression is still not without its dangers. Where pneumothorax has shown to special advantage, and where it has gained its greatest reputation, has been its use in early cases, most of which would have healed by rest without the aid of pneumothorax. Most of these would have healed within a year and would not have been burdened by the many refills and possible complications, extending from two to five years. For example, it would have been little short of malpractice to have used artificial pneumothorax in the 66 per cent of exudative cavities in our series that healed, 95 per cent within the year. Nearly all of these have attained an arrest, or are well along toward recovery. Nevertheless, when compression by pneumothorax can be attained and continued it is a valuable adjunct to treatment in some of those cavities which have not responded to rest and phrenicectomy, and also in cases which may have been seen for the first time, and when the cavities are very large or have thick walls, and

* Shall we recommend a phrenic exeresis or the nerve crushing operation? Alexander's[1] advice seems very sound. He recommends the temporary nerve operation when there is the possibility that more lung surgery may be required to attain results; for example, a thoracoplasty or an extrapleural pneumolysis. Preservation of vital capacity should be the watchword in all chest surgery. In the crushing of the phrenic nerve no lung tissue is permanently sacrificed and crushing may be repeated if required. In phrenic exeresis a definite amount of vital capacity is permanently destroyed. In Alexander's clinic 90 per cent of the primary nerve interruptions are the temporary crushing type. Recently Douglass[6] has reported using the crushing operation in 15 cases, with results comparable to those attained by phrenic exeresis.

where caseation and consolidation are extensive. If, however, an effective compression cannot be reached promptly, it is well not to waste too much time, but to resort to more radical measures. Intrapleural pneumolysis is an important aid in pneumothorax where adhesions interfere. Broga[3] reports 7 of 9 cavities closed by this method, or 77 per cent.

Finally, we have thoracoplasty available when all other means have failed in the treatment of cavities. This is preeminently the operation for fibrotic cavities.

When thoracoplasty began first to be used, the operation was considered very severe and was much feared. Its application was therefore quite limited and it was used mainly as a last resort to save life. The mortality was therefore necessarily high. At the present time, however, by modification of the technique and a better understanding of the indications for its use, its usefulness has been much widened, its objectionable features and dangers having been greatly eliminated. It is no longer a last resort operation, but has its definite indications and is preferably used when the patient is in good physical condition. Not many recent statistics are available as to results attained by thoracoplasty in the treatment of cavities. Hedblom and Watterson[8] report the closure of 11 of 14 cavities by thoracoplasty as an independent operation, or about 78 per cent.

The list of contraindications has also been considerably shortened. At present, the main contraindications are diabetes, syphilis, definite kidney disease and cardiac insufficiency.

Tuberculosis of the larynx, tuberculosis of the intestines, genitourinary tuberculosis and bone tuberculosis are no longer contraindications unless too far advanced. A successful thoracoplasty is an aid in the treatment of these disabilities.

Sauerbruch's indications for pneumothorax: unilateral disease, fibrous types, rigid mediastinum, capable heart, youth, generally good condition, have been extended. The ideal case for thoracoplasty, as stated by Bruns and Casper,[5] is one in which the roentgenograms show a contracted lung containing caseofibrous lesions and cavitation, and one in which the opposite lung is hypertrophied and with little or no involvement; and even some cavitation of the contralateral lung may be acceptable in some cases, provided the lesions are fibrous and the lung shows compensatory hypertrophy.

In the past, the results following thoracoplasty have often been poor, as it was not considered necessary to attain a complete collapse of the cavity at once, concentric contraction being relied on to bring about complete collapse. Now, many phthisiologists and chest surgeons believe that thoracoplasty should not be considered successful unless complete collapse of the cavity is attained at the time of the operation. This may be accomplished by combining an extrapleural paravertebral thoracoplasty with an extrapleural pneumolysis.

Bruns and Casper[5] have perfected such an operation. It is begun by an upper stage thoracoplasty, removing wide sections of from five to seven of the upper ribs, depending on the location of the cavity. Then, an extrapleural pneumolysis is performed, the parietal pleura being stripped from the spine and dome of the thorax. Sometimes the intercostal muscles are severed when extreme collapse is required. The wound is partially sutured, gauze packing soaked in 24 per cent argyrol being applied and packed in firmly, compressing the part of the lung containing the cavity against the anterior chest wall. Firm compression is kept up, repacking firmly when the gauze is changed, until periosteal regeneration is so far advanced that the bottom of the wound is rigid. The above operation, although more tedious to the patient and requiring more after-care by the surgeon, seems much worth while for it will close most cavities, and accessory operations such as lateral anterior thoracoplasties will not be required. Bruns and Casper report 12 cases

operated on by this method, in all of which the cavities were obliterated.

Intercostal neurectomy, scalenectomy and extrapleural pneumolysis with paraffin pack, should be mentioned. The first two are only used as adjunct treatment to the more important surgical measures. The last has given good results in some hands, but other reports are not so good. Its indications are a cavity with not too thick walls, not too near the pleura, and without a great deal of surrounding pulmonary involvement.

SUMMARY AND CONCLUSIONS

1. These conclusions are based on the study of middle-aged groups.

2. To better facilitate the study, the classification of cavities as exudative, productive and fibrotic is again used.

3. As a preface to our conclusions as to treatment of cavities, it should again be stated that the healing of tuberculous cavities depends greatly on their type. The exudative or young cavities respond most favorably to conservative treatment; 66 per cent healed. The productive or moderately old cavities responded less favorably; 43 per cent healed. The fibrotic or old cavities responded the least favorably; only 17 per cent healed. Of all types of cavities, 46.6 per cent healed.

4. The above results compare very favorably with the results claimed by those who are advocates of immediate or early surgery as the main reliance in the healing of cavities, as may be seen in Table II.

5. The results attained by rest in the treatment of exudative cavities are superior to results attained by any of the surgical measures that would be at all suitable for young cavities.

6. It seems only logical to conclude, therefore, that:

(a) Conservative measures of which rest is the most important, should be tried first in all exudative cavities and in a large proportion of the productive cavities.

(b) Nearly all fibrotic cavities should be considered without much delay for surgical procedure.

7. If, after six or eight months' treatment by conservative means, cavities show no tendency to heal, some mechanical intervention should be considered.

8. Phrenicotomy or phrenicectomy is recommended as the first aid to rest in the treatment of the exudative and productive cavities when they show no response to conservative measures. These are simple procedures, much less burdensome than artificial pneumothorax. The elevation of the diaphragm may produce enough decreased lung tension and immobility to materially enhance the results attained by rest and bring about a closure. By this procedure our expectancy for healing of these types of cavities may be increased from 60 per cent (exudative) and 43 per cent (productive) attained by rest, to approximately 75 per cent and 50 per cent respectively.

9. For cavities that do not respond to rest, aided by phrenic nerve operation, and for many older cavities which may have been seen for the first time, artificial pneumothorax is our next resource. The value of this procedure is, unfortunately, often limited, for pleural adhesions will prevent a complete compression in a large percentage of cases for which this operation is suitable. Furthermore, in nearly two-thirds of the cases in which a favorable collapse is attained, the treatment must be discontinued due to the formation of obliterating adhesions.

10. The value of artificial pneumothorax can be increased in a small percentage of cases by intrapleural pneumolysis.

11. Finally, thoracoplasty is available for the treatment of cavities which have not responded to other methods of treatment. This operation is no longer recommended only as a last resort to save life, but is definitely indicated when the patient is in good physical condition. During the last few years, the contraindications for thoracoplasty have been much modified, and due to improved technique its

usefulness has been considerably widened, its objectionable features and dangers having been greatly eliminated. The best results seem to have been attained by a combination of paravertebral thoracoplasty and external pneumolysis, as described by Bruns and Casper.

12. Although the increased perfection of mechanical measures for the treatment of cavities has been one of the most important developments in the field of tuberculosis during the last decade, it appears that routine sanatorium care still holds the place of importance, for the following reasons:

(a) Routine sanatorium treatment of which rest in bed is the most important factor, is suitable for all cases, while the indications for the different mechanical measures cover a much restricted field and should be considered as supplementary.

(b) Some claim a healing of more than 50 per cent of cavities by phrenicectomy. However, as at the same time and for extensive periods, these patients are undergoing routine sanatorium care, how much of the result is due to the operation and how much to rest? Based on our experience, rest seems to us by far the most important factor.

(c) Others claim the healing of more than 50 per cent of cavities by means of artificial pneumothorax. These results are only attained when a satisfactory compression is accomplished and also by the aid, in some cases, of intrapleural pneumolysis. These figures appear meager, however, when it is realized that the artificial pneumothorax field is quite limited, while the field for rest comprises all cavities.

(d) Thoracoplasty, extrapleural pneumolysis, intercostal neurectomy, all of these are valuable adjuncts in the healing of cavities, but again the field is restricted.

In conclusion, although rest or routine hospital care seems to be the one most important factor in the healing of cavities and should be pushed to the limit, we must watch our cases carefully by frequent roentgenograms and resort to mechanical compression promptly when indicated. And, finally, there should be no antagonism between the use of rest and mechanical measures in the healing of cavities, as each has its special field of usefulness, rest being pre-eminently important in young cavities to be supplemented by surgical procedure as the cavities become older.

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ROENTGEN STUDY OF THE GASTRO-INTESTINAL TRACT IN CHRONIC IDIOPATHIC ADULT TETANY*

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THE literature contains few references to the roentgen study of the gastro-intestinal tract in hypoparathyroidism. Our attention was drawn to this subject by the finding of a most peculiar small intestinal stasis as revealed by the roentgen study of the gastrointestinal tract in an adult with chronic idiopathic tetany, who exhibited a dilated small intestine with considerable stasis and laking, together with hypotonicity. This is well illustrated by Figures 1 and 2. The details of this case are presented later.

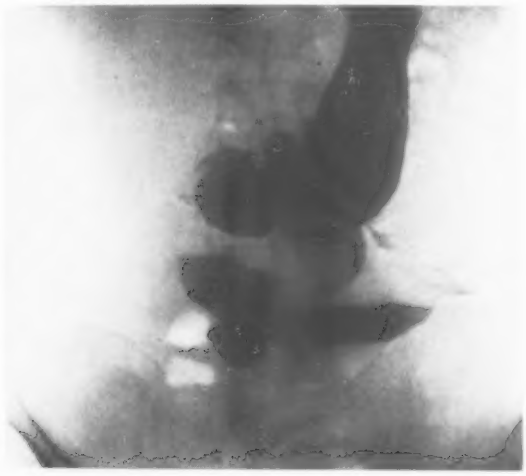

FIG. 1. Film made in the erect posture immediately after opaque meal showing the stomach to be normal but there is considerable dilatation and stasis in the duodenum and proximal jejunum with a loss of the normal small intestinal markings.

FIG. 2. Left lateral view showing position of stomach and small intestines.

SUMMARY OF DATA FROM LITERATURE

1. *Relation of Parathyroid Gland to Gastrointestinal Tract.* Falta[8] noted disturbances in the function of the gastrointestinal tract, as revealed by the roentgen examination, in the greater number of cases of tetany. There was often an abnormally rapid emptying of the stomach. In some cases marked pylorospasm was a feature. He concluded that in the acute stage of tetany the gastrointestinal tract may show signs of increased excitability and a heightened tonus, which later may lead to spasm.

Businco,[5] studying parathyroid deficiency in dogs, noticed profound disturbance in the mechanical function of the intestine. The alteration consisted mainly in a spastic paralysis of the viscera, accompanied by a notable retardation in the progression of intestinal contents. By roentgen study (Figs. 3, 4, 5, and 6, re-

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FIG. 3. Stomach of dog with normal tone (from Businco[5]).

produced from Businco) he found marked stasis especially in the stomach and small intestine. Carlson[6] had previously noted atony in the stomach of individuals with parathyroid tetany. Kratinoff and Kratintoff,[15] using the balloon method in dogs, found increased tone and spasmodic gastric contractions in the severe forms of tetany.

Mahler and Beutel[19] studied the effect of parathyroid extract on man by means of the roentgen examination and gastrointestinal tubes. They observed that this material had no noteworthy influence on peristalsis of the stomach or intestines except some increase in depth of peristaltic waves and, in one case, an acceleration of gastric motility.

Higgins[11] recorded the clinical history and roentgen findings in a patient with visceral tetany. Roentgenograms taken during an attack showed obliterative spasm of the small intestines, but were normal when repeated during a quiescent period. During a seizure of tetany, laparotomy (done because of suspected intestinal perforation) revealed a contraction of the ileum for over 50 cm. to the size of a lead pencil. To our knowledge, the roentgenograms of the stomach and small intestine, as presented by Higgins and Falta, are the only films of the gastrointestinal tract (in man), taken during tetany, available in the literature. Dilatation of the colon in tetany has been described by many authors;[4,13,16,18,20,24] however, in all of these, no mention is made of any unusual findings in the stomach or small intestine.

Tsai[26] removed the parathyroid glands in dogs and found that the stomach no longer exhibited hunger contractions, although no food was taken for several days, and that gastric tone was permanently

FIG. 4. Stomach of dog with tetany (from Businco[5]).

lowered. He also found that parathormone given to normal dogs produced no effect on gastric motility other than partial and temporary inhibition. Injection of parathyroid extract into parathyroidectomized dogs restored gastric tone, but not the anorexia.

2. *Clinical Use of Parathyroid Extract in Gastrointestinal Disorders.* Moutier and Camus[21] have claimed promising results from the use of parathyroid extract in the treatment of peptic ulcer. Sheldon et al[22] call attention to the paucity of references to gastrointestinal disorders in postoperative parathyroid insufficiency and in hyperparathyroid conditions. They have also advocated the use of parathyroid extract in the treatment of megacolon, and have reported 3 cases with marked improvement under this regimen. Recently Hitzrot and Comroe[12] reported a case in which, following parathyroidectomy (for hyperparathyroidism), the patient's extreme constipation was converted into perfectly regular bowel movements.

Fig. 5. Picture of normal dog's intestine (from Businco[5]).

Fig. 6. Dog's intestine during tetany (from Businco[5]).

3. *Rôle of Calcium in Gastrointestinal Disorders.* Inasmuch as one of the important findings in hypoparathyroidism is the presence of a low serum calcium level in the blood, this discussion would be incomplete without a brief survey of the relation between calcium therapy and gastrointestinal pathology. The coincidence of a low serum calcium level and peptic ulcer has been commented upon by various writers.[1,9] It has been noted that nausea and vomiting frequently occur following rapid intravenous injection of calcium salts, especially the chloride. Dramatic relief from abdominal pain in the so-called colic from lead poisoning, renal or gallstones, has been reported by the use of calcium chloride given intravenously, pre-

sumably due to an antispasmodic effect of the calcium.[3] Sollmann[23] has shown that calcium given intravenously may lead to an arrest of peristalsis in toxic doses. Kennedy[14] showed that the tone and peristalsis of strips of uterine muscle are lost by an increase in the calcium concentration in the surrounding fluid. Timme[25] has noted in patients with a low serum calcium a spastic colitis, and Haskell and Cantarow[10] have obtained clinical cures in cases of chronic ulcerative colitis with a regimen including large doses of calcium given orally and parathormone subcutaneously, and postulated that the calcium may decrease peristalsis by acting through the vegetative nervous system. Only a small proportion of the calcium intake is absorbed, as calcium salts are absorbed with great difficulty from the stomach and intestine, and retard the absorption of fluid. Animal experiments have failed to explain the beneficial effect of calcium in cases of gastrointestinal spasm.

CASE REPORT

The patient, D. M., a white Italian male, aged thirty-eight, was admitted to the surgical ward of Dr. George P. Muller, February 3, 1932, with a chief complaint of epigastric pain. Because of the finding of a most unusual appearance in the roentgen examination of the gastrointestinal tract, the case was transferred to the medical service of Dr. Alfred Stengel, in the University Hospital.

The history dates back to a severe diarrhea beginning sixteen years previously (1916) which was ascribed to dietary indiscretions. At that time the stools were watery and yellowish, but did not contain visible blood. This persisted in attacks of approximately a week's duration for several years (especially during the summer months), and was often associated with a slight fever. These were at times severe enough to so weaken the patient as to confine him to bed. This severe diarrheal condition persisted intermittently for ten years, gradually lessening in severity until 1930, when it ceased entirely.

For the past several years, the patient noticed that he tired very easily and could no longer do his farm work with his usual vigor. This weakness increased until he was forced to rest after very slight manual effort. Bowel movements decreased in number and constipation set in. During 1932 the patient had an average of three movements per week. Coincident with this, there was some straining at stool and occasionally streaking of the feces with red blood.

In 1930 abdominal pain was first noticed, similar but slightly sharper than a "hunger pain." This remained localized to a spot just beneath the lower end of the sternum. The pain, at first present every day, decreased somewhat until on admission there were periods of one to two weeks' freedom from discomfort. There was no relation of the pain to food, and no relief from medication.

During 1931, moderate edema of the ankles appeared, coincident with the sensation of "pins and needles" over the entire body, especially marked in the extremities.

The only additional historical data are the loss of 16 pounds in weight (145 to 129) during the previous three years, and some nocturia. The past medical and family histories were negative. The patient was born in Philadelphia of Italian extraction. He had worked on a farm since the age of nine. He had not used alcoholic beverages in excess, and had always been on a very liberal and well-balanced diet, including plenty of milk.

Physical examination on admission revealed a dark complexioned Italian male, with a slightly subnormal temperature, asthenia, poor oral hygiene, marked clubbing of the fingers and toes, and a blood pressure of 94 systolic and 60 diastolic. The heart and lungs were negative on physical examination. Because of the asthenia, vascular hypotension, pigmentation, and subnormal temperature, a tentative diagnosis of Addison's disease was made.

Routine laboratory studies showed a slight secondary anemia with a white blood count of 15,000, a normal differential picture, repeatedly negative urinalyses, a normal sugar tolerance curve, and a negative Wassermann reaction with all antigens. The basal metabolic rate was minus 12 per cent. Phenolsulphonphthalein showed 90 per cent elimination of the dye in two hours, and fractional gastric analysis was normal.

Because of the abdominal pain, a roentgen examination of the gastrointestinal tract was made, which revealed a most amazing appearance (Fig. 1). The report (February 4, 1932)

Fig. 7. Film made in the recumbent posture immediately after the preceding examinations (Figs. 1 and 2). Note that the jejunum has a large amount of contents in it. The normal markings are absent and this portion of the intestine is dilated.

Fig. 8. Film made one hour after the meal. Note the distribution of the contents throughout the small intestine and the dilatation of the duodenum and jejunum.

was as follows: The stomach was J-shaped, orthotonic, with the greater curvature 3 inches above the level of the iliac crests. There was hypoperistalsis with very marked hypermotility. The barium passed readily from the stomach into the duodenum. The second, third, and fourth portions of the duodenum were very markedly dilated (Figs. 2 and 7). The barium filled the duodenum and the volume appeared to be almost equal to that remaining in the stomach. The jejunum just distal to the ligament of Treitz was also dilated (Fig. 8). There appeared to be a pooling of the contents throughout the small intestine (Fig. 9). There was a small four hour residue in the stomach (Fig. 10). The marked dilatation of the jejunum and probably most of the ileum resulted in the absence of valvulae conniventes and the presence of many fluid levels. There were normal haustral markings in the colon at the twenty-four hour examination (Fig. 11). Dr. H. K. Pancoast, when consulted, remarked that he was at a loss to explain the marked small intestinal stasis and had never before seen a similar appearance.

After several days in the ward, a senior clinical clerk (Mr. Nadel) noticed that while taking the patient's blood pressure an adduction of

Fig. 9. Film made in the erect posture two hours after the taking of the first meal.

FIG. 10. Film made four hours after the first meal. Note the slight gastric residue with distribution of the remainder of the contents throughout the small intestine and with the head of the meal in the ascending colon.

the fingers and arm together with flexion resulted, the so-called "obstetrical hand" typically seen in tetany. Other signs of tetany were then searched for and found—i.e., positive Trousseau and Chvostek's signs, a low serum calcium (5.3 mg. per cent), and typical electrical reactions (testing the right ulnar nerve—C.C.C. ½ ma., A.C.C. ½ ma., A.O.C. 1½ ma., C.O.C. 2 ma.). As is often the case in tetany, this patient exhibited a large number of fine, granular, lenticular opacities bilaterally (seen with the aid of a slit lamp).

A diagnosis of tetany of unknown origin was made and further tests to determine the causation of the condition were undertaken. An electrocardiogram revealed prolongation of the electrical systole with a slight tendency toward left axis deviation, as is often seen in tetany. A roentgen examination of the humeri, right forearm and wrist, pelvis, femora, and teeth, was negative for any evidence of decalcification or other bone pathology. Blood serum protein was 5.4 mg. per cent and serum phosphates 4.5 mg. per cent. The pH of a specimen of venous blood was 7.39. Feces examinations were repeatedly negative for ova, parasites, and protozoa; there was no excessive amount of undigested muscle or fatty tissue present.

Fifteen grams of calcium lactate (in milk) were given daily. After five days of this regimen, there was no change in the blood calcium level or in the patient's general condition. Calcium chloride, 18 grams daily (in milk) was then begun resulting in four days in a serum calcium of 6.9 mg. per cent. In a week, the symptoms of tetany had disappeared, and the blood calcium rose to 7.4 mg. per cent. A peculiar subjective rubbing sensation over the abdomen was still noticed by the patient. The electrical threshold rose slightly, but was still below normal. The dosage of calcium chloride was increased to 30 grams daily, and later to 45 grams, on which the patient became so comfortable that he insisted on returning to his farming duties. Plasma carbon dioxide was at all times within normal limits. While at home, on those days on which he failed to take the prescribed dosage, numbness and tingling appeared in his hands, together with the above mentioned abdominal discomfort. Several months following discharge, blood serum calcium was 8.9 mg. per cent and plasma carbon dioxide 53 volumes per cent. The patient's bowels moved one to two times daily, and were of normal color and consistency. The gastrointestinal examination made one month later, March 7, 1932, showed a similar appearance as reported except that the colon did not present the typical haustrations (Figs. 12, 13 and 14). A roentgen examination made on April 12,

FIG. 11. The colon at the twenty-four hour examination was entirely within normal limits of appearance.

Fig. 12. Appearance of the stomach, duodenum, and jejunum one month after the first examination. There is very little, if any, change in the appearance of the small intestines. Compare with Figure 1.

Fig. 13. Examination made one hour after the meal. Compare with Figure 8. Note that there is practically no change in the appearance of the small intestine.

1932, at a time when the patient was receiving calcium chloride 45 grams daily and when the symptoms of tetany had disappeared, showed a distinct improvement in the tone of the gastrointestinal tract. There was still some small intestinal stasis (Figs. 15, 16, and 17). However, the dilatation and stasis were not as marked and the small intestinal markings (valvulae conniventes) were definitely visualized for the first time.

A gastrointestinal examination made on November 10, 1932, nine months after the first examination, showed considerable dilatation of the small intestine but not as great as at the first examination (Fig. 18). The valvulae conniventes were not visualized. His clinical findings at this time had not changed since the previous examination except that the abdominal discomfort and feelings of numbness were absent. Another examination was made on May 3, 1933. The findings were similar to previous ones. No changes in the roentgen picture were noted after a short trial of parathormone (20 units daily for five days), and a prolonged intake of 2 c.c. of viosterol daily.

Because of his seemingly good health (and his distrust of hospitals), he could not be induced to remain for calcium phosphorus bal-

Fig. 14. Twenty-four hour examination. Note that the normal haustral markings in the colon are absent. Compare with Figure 11.

FIG. 15. Film made two months after the first examination. Compare with Figures 1 and 12. Note that the duodenum and jejunum are not dilated to the degree seen in the first examination.

ance studies, and returned to his home, where, we were informed, he died very suddenly one month later. Post-mortem examination was refused.

COMMENT

The etiology of tetany in this individual unfortunately remains obscure. One might speculate whether the tetany was the cause or the result of the peculiar gastrointestinal picture. It was pointed out (by Dr. O. H. Perry Pepper) that the long-standing diarrheal disorder might predispose to intestinal amyloidosis, with resultant poor absorption of ingested calcium, followed by tetany. A Congo red test revealed findings which might be interpreted as significant of that condition. Ten cubic centimeters of a 1 per cent solution of Congo red was given intravenously and samples of blood and urine obtained in four and sixty minutes. There was no evidence of the dye in the urine, while there was an appreciable decrease in the intensity of the dye in the two samples of blood serum, showing that some of the Congo red might have been retained in amyloid tissue. However, the relief of symptoms subsequent to calcium therapy orally makes this quite questionable. Hypoparathyroidism is our most acceptable diagnosis.

After medication there was a distinct improvement in the appearance of the gastrointestinal tract, which, however, never returned to normal. Small intestinal stasis and dilatation occur as a result of a number of conditions, but the peculiar appearance shown above has never been observed by us even in cases of marked peritoneal irritation such as is seen in ascites. We have examined a second adult with chronic idiopathic tetany[17] through the courtesy of Dr. Simon S. Leopold. The gastrointestinal roentgen appearance was entirely negative during a symptom-free stage and without hypocalcemia.

DISCUSSION

The cause of the small intestinal stasis in this patient is uncertain, but probably

FIG. 16. Film made two hours after the first examination. Compare with Figure 9. Note the return of the normal small intestinal markings to a slight degree.

resulted from a disturbance of intestinal innervation. The musculature of the intestine is supplied by two sets of nerve impulses, the vagus, stimulation of which usually produces at first a slight lowering of gastric and intestinal tone, which is soon followed by an increase in tone and activity—lasting for from a few seconds to a minute,[7] and the sympathetic, the main effect of stimulation of which results in an inhibitory action. However, Alvarez[2] has stressed the fact that both are mixed nerves so that the actual nervous mechanism involved cannot be accurately determined.

The influence of the parathyroid glands on the gastrointestinal tract is doubtless a result of the alteration in blood calcium level, a lowering of which (as in hypoparathyroidism) is accompanied by a hyperexcitability of the central and peripheral nervous system. The underlying change in tetany is a hyperexcitability of the nervous system as demonstrated by the greatly increased response of the brain and peripheral nerves to electrical stimulation. Obliterative spasm of the small intestine in tetany (as reported by Higgins[11] and confirmed at operation) is probably due to overaction of the vagi, due to the hypocalcemia. The picture in chronic tetany, with dilatation, stasis, and laking in the small intestine, together with hypotonicity, and non-visualization of the valvulae conniventes, remains unique and without adequate physiological explanation. Removal of calcium appears to result in increased irritability of terminations of the autonomic nerves in mammals.[7] Thus, we would expect in a hypocalcemia a spastic condition of the intestines, rather than a dilatation, stasis, and laking. As Sheldon et al[22] have suggested in relation to the huge colon, found in megacolon, this condition may be the result of spasm in sphincter regions with dilatation proximal to this. This same phenomenon may exist in cases of chronic tetany, and, in addition, hypotonicity may result from the stasis and dilatation incident to prolonged and often repeated sphincteric spasm in advance of the lesions.

Fig. 17. Film made at the same time as Figure 16 in the recumbent posture

Fig. 18. Film made in the recumbent posture two hours after the giving of the opaque meal. Note the dilatation of the small intestine which was similar to that of the first examination although not quite so marked.

SUMMARY

1. The case of an adult with chronic idiopathic tetany is reported with a most unusual gastrointestinal roentgen appearance.

2. The features of the roentgen examination were as follows: Stomach: Hypertonicity, hypermotility, and hypoperistalsis. Pylorospasm was not conspicuous in any of the examinations. Duodenum: Widely dilated. Small intestine: Moderately dilated with considerable stasis and laking. Hypotonic, valvulae conniventes not visualized. Colon: Apparently normal in appearance.

3. The literature concerning the influence of the parathyroid and calcium metabolism on the gastrointestinal tract is summarized.

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CONGENITAL ANOMALIES OF THE ALIMENTARY TRACT

WITH SPECIAL REFERENCE TO THE CONGENITALLY SHORT ESOPHAGUS*

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THE congenital anomalies of the alimentary tract are quite numerous and varied and are found involving almost every portion of it. It would be impossible to treat all of them well in one brief paper but it does seem reasonable to speak of them in groups; to consider the responsibility that is ours in a diagnostic way; to consider the matter of terminology in certain of them, and to make a few suggestions that may be helpful in bringing to light the many cases that we believe exist, rather than the relatively few that have been reported up to the present. We are claiming no priority and it has been impossible to read all of the literature available. We are discussing the subject largely because of the cases we have been privileged to study.

These variations from the normal, except in the atresia group, are frequently entirely compatible with the ordinary customs and modes of living. Doubtless many persons having them go through life without manifesting symptoms referable to them. On the other hand, when disturbances do occur, they so often simulate symptoms of the more common diseases that diagnosis is frequently wrong or incomplete because of incomplete or lack of proper study. We believe, too, that a definite percentage of the atresia cases could be saved by surgical methods if a complete diagnosis were made early enough.

The congenital maldevelopments below the diaphragm must be overlooked frequently when one considers that the majority are found at autopsy, and that probably only a very small percentage of such cases ever come to autopsy or even to roentgen study. One need but mention "pyloric spasm" or "pyloric hypertrophy," "visible gastric peristalsis," etc., to bring to mind the clinical picture of many of these unfortunate infants who fall in the groups of atresia, or variation in the lumen, or partial obstruction due to congenital membranes. There is relatively little in the roentgen literature concerning such conditions, largely because no one roentgenologist has seen any large number. We feel that any diagnostic experience concerning them should be recorded and indexed in such a way as to make it easily available.

For the sake of convenience, we will consider the following groups:

1. Atresia
2. Variation in lumen
3. Variation in length
4. Variation in position
5. Adventitious membranes
6. Diverticulum

Atresia is relatively common and occurs in all portions of the alimentary tract, most frequently in the esophagus, the jejunum, and duodenum, and less frequently in the ileum, colon and stomach. Atresia of the esophagus is diagnosed with certainty by means of a small quantity of barium mixture being swallowed under roentgenoscopic observation. So far as we know, it has not yet yielded with permanent success to surgical interference. We all believe, however, that some surgeon will one of these days find a solution.

The length of the upper or blind end varies appreciably. Knerr[18] reported a case under the title, "Congenital absence of the esophagus." The blind end was certainly very little if at all below the pharyngo-esophageal junction.

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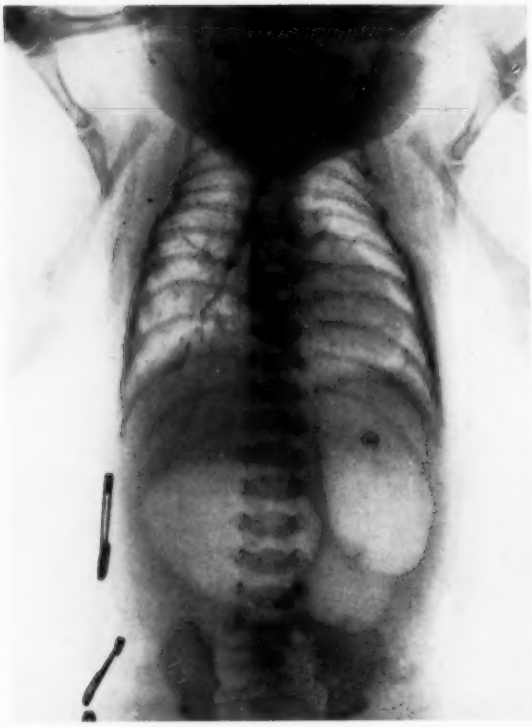

Fig. 1. There is complete absence of the esophagus. The barium mixture passes directly into the trachea from the pharynx. The lower segment of the esophagus evidently joins the trachea near the bifurcation. There is a small amount of barium mixture in each main bronchus and a very small quantity in the stomach. Note the distention of the stomach with air and particularly the marked dilatation of the first portion of the duodenum, at which point there is complete obstruction. There is no air in the intestines beyond this point.

In one of our cases the pharynx ended a few millimeters below the level of the larynx (Fig. 1). This was found at autopsy. On roentgenographic study the barium mixture passed down the trachea to the bifurcation where the lower portion of the esophagus joined its lumen, so that on the roentgenoscopic screen and in the roentgenogram, one had the impression that the stream went through a relatively normal esophagus. It is remarkable that only a small portion of the mixture went into the right bronchus and very little into the left bronchus. There was definite delay at the lower end of the esophagus, which was thought to be due to spasm, and no mention was made in the autopsy report of any maldevelopment at this point. The stomach and first portion of the duodenum were greatly distended with air, but there was no air or gas beyond this. It was found at autopsy that, in addition to the atresia of the esophagus and duodenum, there was also atresia of the rectum—in short, a number of points of congenital atresia.

In another of our cases (Fig. 2) the blind end was just behind the manubrium, and in still another very near the level of the bifurcation of the trachea (Fig. 3). The esophagus above this level was dilated or at least larger than the infant esophagus should be. It was tolerant, too, because a considerable quantity of bismuth remained over a period of six hours. It was quite evident that the lower portion of the esoph-

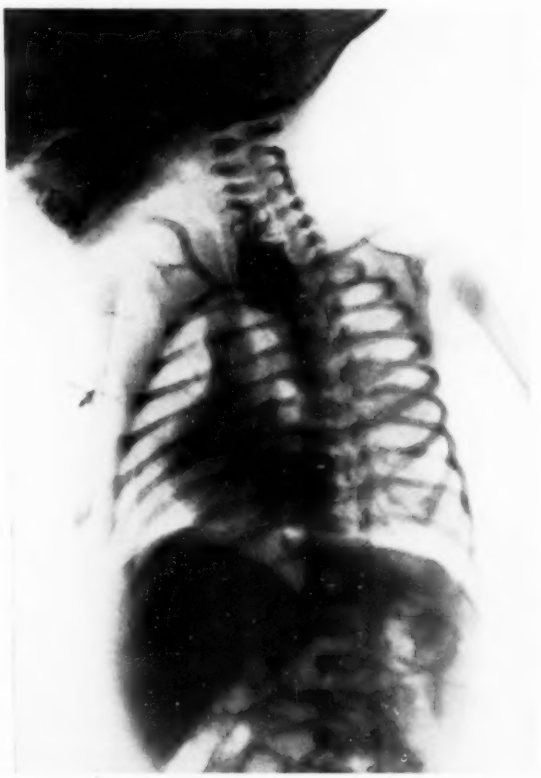

Fig. 2. The usual type of esophageal atresia. The upper segment of the esophagus terminates just below the suprasternal notch. Note the normal distribution of air in the stomach and intestines, showing that the lower segment of the esophagus does communicate with the air passages.

agus communicated with the respiratory tract because of the large amount of air in the stomach and intestines. It is probable that the two ends of this esophagus were fairly near each other. This type should offer reasonable prospect of favorable surgical result, but in this instance it was not attempted. Early diagnosis would always be prerequisite to surgical intervention, and the report should indicate particularly the length of the upper segment, or, rather, the level, with relation to the vertebrae, at which it terminates.

We have not seen a case of congenital atresia below the level of the bifurcation of the trachea, but we did have a patient who developed complete obstruction of the lower end of the esophagus at approximately four months of age, but had difficulty in swallowing starting three weeks after birth. The child thrived well after gastrostomy until the age of nineteen months when he was brought to the Jefferson Hospital Bronchoscopic Department where we reconstructed the lumen of the esophagus by means of two esophagoscopes and other instruments under double plane roentgenoscopic control. Subsequent dilatation brought about a serviceable esophagus for the child.

When there is atresia of the upper esophagus, air in the stomach and intestines gives definite information that the lower segment of the esophagus communicates with the respiratory tract. Tucker and Pendergrass[24] report a case in which this point of communication was seen through a bronchoscope, and under roentgenoscopic control a ureteral catheter was passed through this opening into the lower segment of the esophagus and stomach.

This same sign of air in the stomach and intestines may be depended upon to determine approximately the location of an atresia at a lower level. It must be remembered, however, that there may be multiple atresias beyond the first one demonstrated thus in any case. Atresias of the lower colon may be located by very careful colon injection of barium under roentgenoscopic control.

Fig. 3. The termination of the upper segment of the esophagus reaches to the level of the bifurcation and must therefore be very close to where the lower segment of the esophagus joins the respiratory tract, as shown by the air in the stomach and intestines.

Atresia in the intestines is of two types —one in which a membrane or diaphragm completely blocks the lumen and another in which the lumen has failed to develop.

Garvin[10] reports a case of the former. The patient died five days after birth. At autopsy a membrane was found to obstruct the duodenum 4 cm. below the ampulla of Vater. The lumen of the proximal portion was somewhat large and terminated abruptly. It is almost a certainty that this could have been demonstrated by roentgen study. The lumen beyond this point was normally patulous, and at least the colon could have been studied roentgenologically with rectal injection of air

or an opaque mixture. This was probably a curable condition.

When the atresia is due to failure of the lumen to develop, the situation might be more difficult to demonstrate roentgenologically, but one should make the effort whenever symptoms of obstruction are present. We present post-mortem illustrations of such a case diagnosed clinically soon after birth by reason of marked distention of the abdomen and the failure of the infant to retain liquids. In this case Lemmon[19] anastomosed the jejunum to the transverse colon, which was the first part found to have a lumen from there to the rectum. Between the points of anastomosis there was extensive absence of intestine and multiple complete atresias. Lemmon's patient lived twenty-two days on food taken by mouth. The patient might have continued to live if there had been more small intestine.

Fig. 4. Note the extremely small, thread-like lumen of the few coils of the upper small intestines, probably high up in the jejunum. The rest of the intestinal coils show normal lumen by the air or gas that is present.

The cases of Garvin and Lemmon are quite unusual and represent extremes of the two types.

In one of our cases it was evident from the distribution of intestinal gas that the point of atresia was well toward the distal end of the alimentary tract. No gas shadow was evident in the pelvic area, and we were unable to inject any barium mixture beyond the rectum. So it was evident that the obstruction was in the sigmoid. Neither operation nor autopsy was performed. A number of observations must be made in such an instance because it is conceivable that reverse peristalsis might vary the distribution of intestinal gas.

Variation in the lumen may be found in any portion of the tract. Most of our cases of congenitally short esophagus had some degree of narrowing of the esophagus. In some, contraction of scar tissue following ulcer was clearly the cause, but in others no ulcer was seen. Two of these were brought to light because of obstruction of the esophagus by a bolus of food lodging in a congenitally narrow as well as short esophagus. In some of them a degree of dilatation was present, but this may have been acquired rather than congenital.

We have not encountered any cases of congenital variation in the lumen of the stomach.

We wish to present a case in which there was clinical evidence of obstruction, but a roentgenogram of the abdomen showed air in practically all portions of the intestinal tract, so that at least obstruction was not complete (Fig. 4). It was thought then to be a case of pyloric spasm or hypertrophy. A roentgen study with a small quantity of barium showed the stomach, pylorus, and first portion of the duodenum to be normal in appearance and willing to function normally, but the lumen of the rest of the duodenum and at least a portion of the jejunum was extremely narrow. The barium passing through this area gave a

thread-like shadow. Air or gas in the intestines beyond this point showed all portions to be patulous. This we believe was an operable condition but operation was refused.

The lumen of the tract may be large, as, for example, the colon in Hirschsprung's disease, and this is of interest to us because roentgenological study alone will confirm and complete the diagnosis by determining the extent of involvement.

Variation in length may involve the esophagus, the small intestine, or the large intestine. Below the diaphragm when not associated with atresia it makes little difference whether the intestines are long or short, until the patient comes to suffer from stasis, ptosis, or possibly volvulus of some redundant portion.

The short esophagus, however, presents a more interesting as well as more complex set of problems. There is interest for the internist who believes the condition—perhaps under another name—is a medical one from the viewpoint of treatment; there is interest for the surgeon who feels it is a surgical problem when definite symptoms exist; there is interest for the esophagoscopist who sees the ulcer, when present, and perhaps does something to improve the situation, and dilates strictures that are sometimes found, and he also has definite interest from a diagnostic point of view when he encounters gastric mucous membrane before the esophagoscope reaches the level of the diaphragm; and there is something of real interest for the roentgenologist who will make a thorough study of the esophagus, as well as of the stomach, when he finds the opportunity.

The complexity appears when we consider the diagnostic problems and the terminology used in the literature to describe the condition that exists when the esophagus is congenitally short.

Prior to the use of the roentgen ray, hernia of the diaphragm was diagnosed infrequently. Now, we believe that if complete roentgen study of the esophagus, as well as the stomach, had been made in all of the cases reported, many of these would be listed as cases of congenitally short esophagus. We are certain it would be so if, in addition to complete and careful roentgen study, a thorough esophagoscopic examination had been made in each case with this thought in mind. We feel, too, that the term "hernia of the diaphragm" or "hiatal hernia" should not be applied to the congenitally short esophagus because it implies that the stomach was in the abdomen at one time and later herniated through the diaphragm. The evidence is strongly in favor of the belief that the condition is due to maldevelopment of the esophagus. The portion of the stomach found above the diaphragm probably never has been in the abdomen. It is not a hernia in a true sense. It is more nearly proper to speak of the condition as "thoracic stomach," but even this term we feel should apply only when the entire stomach is in the chest, as it was in Bailey's[2] case and as LeWald[20] described it. This term at least distinguishes the condition from that found in congenital absence of the diaphragm when both stomach and intestines are in the thorax.

Goodall and Hoyt[11] have recently used the term "thoracic stomach" to apply when only a small portion of the stomach is above the diaphragm. This leaves out of consideration the actual cause of the condition, viz., congenital maldevelopment of the esophagus. One might as well speak of a left-sided appendix to describe non-rotation of the cecum or transposition of the viscera.

As a matter of fact, Åkerlund[1] in 1926 used all three of these terms. He classified hernia through the esophageal hiatus as follows:

1. Hiatus hernia with congenitally short esophagus (thoracic stomach)
2. Para-esophageal hiatus hernia
3. Hiatus hernia not included in 1 and 2.

In 1924 Fineman and Conner[8] reported 5 cases in which the esophagus was congenitally short, but listed them as cases of right diaphragmatic hernia of the short esophagus type.

More recently Monkhouse and Montgomery[22] have used the term "partial thoracic stomach" in reporting 7 cases with short esophagus of mild degree.

In 1931 Findlay and Kelly[7] reported a group of cases, all young children, under the title: "Congenital shortening of the esophagus and the thoracic stomach resulting therefrom."

Then there are literally hundreds of articles published as congenital diaphragmatic hernia or hiatal hernia without mention as to whether the esophagus was long or short.

Hedblom[15] evidently did not consider the short esophagus and partial or complete thoracic stomach as hiatal hernia. At least, he did not take it into consideration in speaking of surgical treatment of diaphragmatic hernia. Nor does he mention the esophagus in considering the roentgenologic diagnosis of hernia except to differentiate hernia from esophageal diverticulum. He further says of hernia: "Positive proof usually rests on the demonstration of a portion of stomach or bowel above the diaphragm following a barium meal or enema."

Healy[14] in reporting the symptoms of a group of cases of non-traumatic diaphragmatic hernia says: "My diagnosis has been made on a single direct sign, namely, the demonstration of a portion of the fundus containing an opaque medium above the diaphragm."

This sign was present in all of our cases, but complete roentgenologic study of the esophagus as well as the stomach, and especially the thorough study of the esophagus with the esophagoscope has put our cases in the group of congenitally short esophagus rather than hiatal hernia.

LeWald[21] does not even mention the esophagus in his classification of certain congenital and acquired conditions of the diaphragm, which is as follows:

i. Absence of left half of diaphragm
ii. Thoracic stomach
iii. Eventration of the diaphragm
iv. Congenital hernia
v. Acquired hernia.

He does mention the shortness of the esophagus in connection with thoracic stomach, but he limits this term to the stomach that is entirely above a normal diaphragm having a normal esophageal hiatus.

So there is a lack of uniformity in listing or indexing this condition in which the esophagus is short and a portion of the stomach must of necessity stay above the diaphragm.

Then there is the serious question as to whether the large number of so-called "congenital hernias" reported in the literature have been studied with the possible existence of short esophagus in mind. Or to put it differently, we believe many of them are diagnosed without this differential point in mind and quite a few do have the short esophagus. Fineman and Conner[8] made the excellent suggestion that steps be taken to determine the length of the esophagus in each case of supposed hernia of the diaphragm. To this we would add that, in addition to roentgen study, a careful esophagoscopic examination should be made.

We have previously described[4,5] the roentgen signs that obtained in our cases. A little modification is in order as a result of further study, and a brief description is important here.

A portion of the stomach must be shown to stay above the diaphragm. The esophagus must be shown to be too short to reach the diaphragm.

The opening in the diaphragm has been quite large in all of our cases, except one, which had a carcinoma that involved both the esophagus and the portion of the stomach that was above the diaphragm. Even in this case the hiatus stayed open.

We were able to demonstrate gastric rugae shadows through the diaphragm in various positions (Fig. 5). It is necessary to fill both the stomach and esophagus completely to determine how much of the stomach is above the diaphragm, as well as the length and size of the esophagus (Fig.

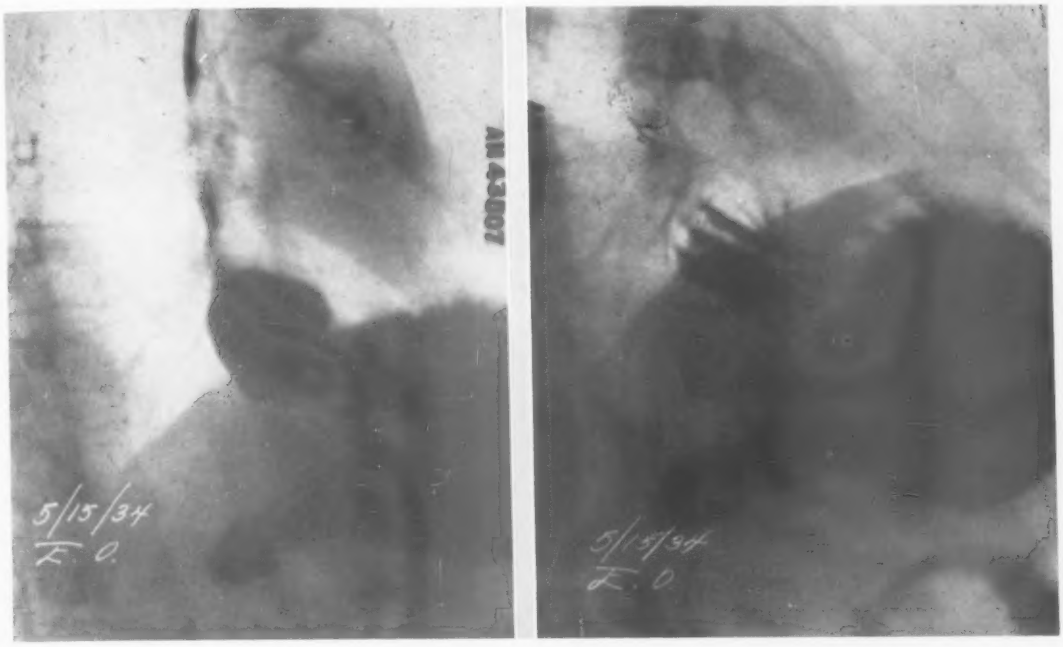

Fig. 5. The left shows expanded portion of the stomach above the diaphragm filled with barium; the esophagus entering at the apex of that portion of the stomach above the diaphragm. The right shows the gastric rugae passing through the hiatus, with a considerable quantity of air in the stomach above the diaphragm.

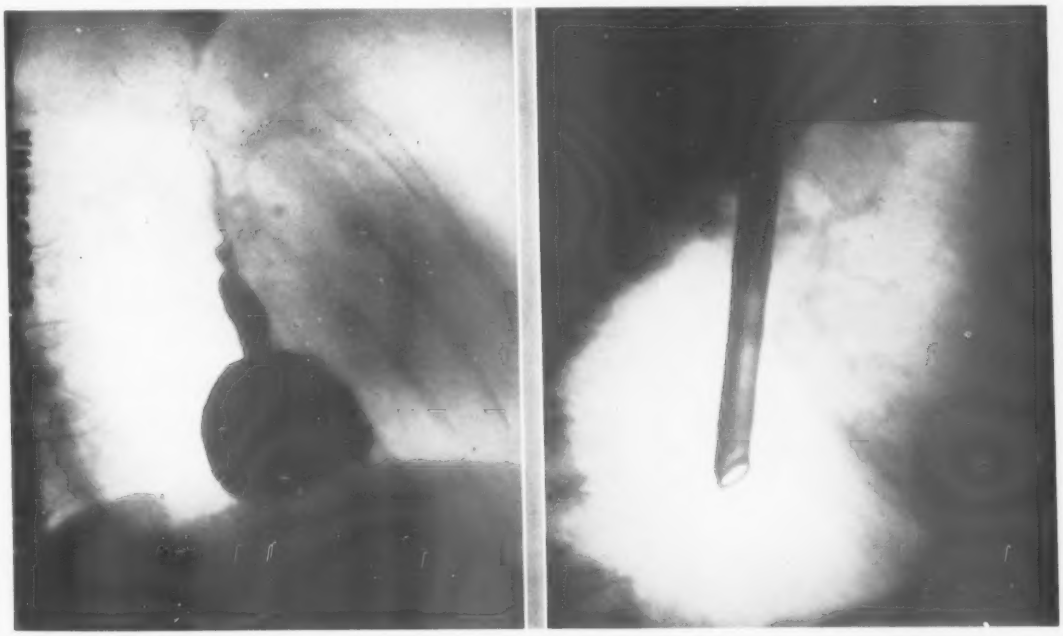

Fig. 6. This shows that the portion of the stomach above the diaphragm is expanded and there was marked narrowing of the lumen at the esophagogastric junction. The esophagoscope on the right is at the point where the esophagus and stomach join.

6). In some this portion of the stomach expanded and had a saccular appearance, and in others it had a more or less tubular appearance or the appearance of an in-

verted cone or funnel, as Clerf calls it, though larger than the normal esophagus (Fig. 7). Most of them show a definite narrowing where the esophagus joins the stomach (Fig. 8). The gas bubble is absent below the diaphragm, when the patient is in the erect posture, but collections of air are frequently seen in the stomach below the diaphragm when the patient is in the right oblique prone posture.

Children are best viewed in the supine posture and it is necessary to do so at times. A moderate lowering of the head end of the patient is sometimes desirable, though unnecessary if the stomach is properly filled. There is entire absence of the "pinchcock" effect at the hiatus. The esophago-gastric junction can be determined with considerable certainty in the roentgenograms and in most of our cases

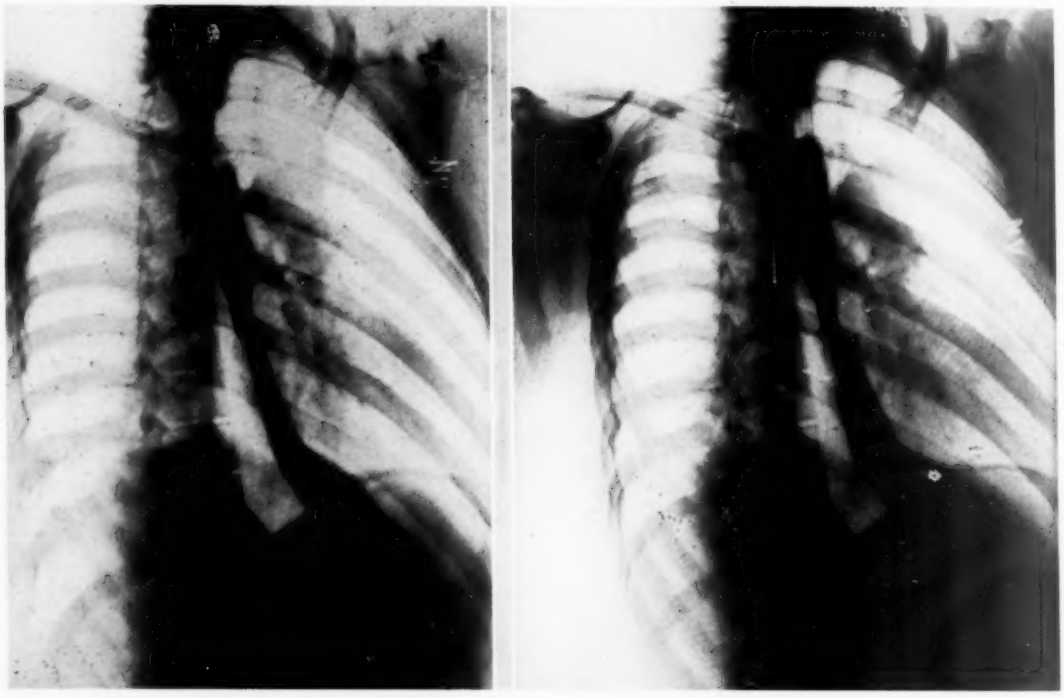

Fig. 7. That portion of the stomach above the diaphragm is tubular and not saccular. Note the extreme width of the hiatus. This was constant. This patient was treated in earlier childhood for a stricture of the esophagus. It has been dilated so that the lumen is now of fair size. The exact point of junction of the esophagus and stomach not noted in the film; with the esophagoscope it was found to be quite high.

The portion of the stomach above the diaphragm empties readily when the patient is erect, but retains barium mixture when gravity is directed toward the upper end of the esophagus, or it regurgitates toward the mouth.

The esophagus and stomach should be viewed from many angles to make certain that it does not go down behind or to one side of the stomach. The best roentgenograms of adults are obtained with the patient in the right oblique prone posture.

it has been at about the level of the seventh or eighth thoracic vertebra, but a few have been lower and a few higher. In one case there was more than one narrow point because a bolus of food lodged well above the junction of the esophagus and stomach.

We have not been able to demonstrate roentgenographically esophageal ulcers that were seen through the esophagoscope.

Monkhouse and Montgomery[22] recognized two groups: (1) those with dysphagia and (2) those without dysphagia. Practi-

cally all of our cases had some degree of dysphagia, and it is interesting to note that nearly all were sent to the Bronchoscopic Department for study of the esophagus before being sent to the Roentgen Department.

Fineman and Conner described practically all of the roentgen signs above mentioned and recognized the importance of esophagoscopy in 1924.

The clinical findings vary greatly in the groups of cases reported. This is probably due in part to the fact that in certain of these groups no attempt has been made to distinguish between cases of congenitally short esophagus with thoracic stomach and true hernia of the diaphragm unassociated with this congenital defect. In the group reported by Findlay and Kelly,[7] vomiting or regurgitation of food with disturbances in growth and nutrition were the outstanding symptoms and were observed in all of their cases. Their group consisted of 9 children. In Monkhouse and Montgomery's 7 cases, all of whom were adults, two groups of symptoms were described, one with, the other without dysphagia. All of our cases complained of dysphagia; in fact, 7 came to the Bronchoscopic Clinic because food had lodged in the esophagus. We were able to divide our cases into two distinct groups so far as the symptoms were concerned. In one, the outstanding symptoms were dysphagia and regurgitation with disturbances in nutrition and growth, as observed by Findlay and Kelly. In the other group, distress, varying from slight indigestion to severe epigastric pain occurring particularly after eating, was noted in addition to dysphagia with lodgment of food and regurgitation.

In the cases described by Goodall and Hoyt[11] the symptoms were divided into two distinct groups, namely, cardiorespiratory and gastrointestinal. In the former, dyspnea was the characteristic symptom. Curiously this was not observed in any of our cases. In many of the cases reported by Hedblom,[15] symptoms such as dyspnea, cyanosis, palpitation and a feeling of fullness and suffocation were noted. Hurst's[16] cases developed symptoms of pain which simulated angina pectoris. Harrington[13] reported the occurrence of pain which may be referred to the left shoulder and radiate down the arm. He ascribed this to spasm of the diaphragm. This was not observed in any of our cases. It would seem that these symptoms would not be observed in the congenitally short esophagus case in which the so-called hernia is fixed and irreducible.

Fig. 8. Note narrowing at point where the esophagus and stomach meet. This was confirmed by means of the esophagoscope. The entire esophagus and stomach are completely filled with barium mixture. The hiatus remained open to the extent shown here throughout a prolonged study.

Few of the reported cases of short esophagus have been examined esophagoscopically. In those examined, fairly constant findings were recorded. These consisted of a short esophagus, narrowing at the esophagogastric junction, finding a dilated portion of the food passageway lined by gastric mucosa above the diaphragm level and the absence of the normal

hiatus oesophageus. The short esophagus could be recognized by making measurements and also by ascertaining the position of the tip of the esophagoscope in relation to the bony landmarks of the chest. The narrowing at the esophagogastric junction was fairly constant; in several patients it was quite marked and presented the appearances of a cicatricial stenosis. In 7 of our cases there was a history of lodgment of food. The character of the narrowing varied somewhat. The lumen was practically always concentrically placed and

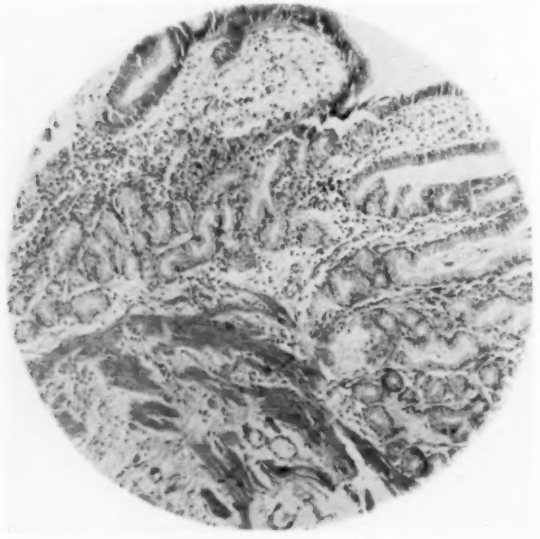

Fig. 9. Glandular mucosa removed esophagoscopically from the food passage above the level of the diaphragm. Although normally this would correspond to the esophagus, in this case the gross appearances of the mucosa were those of stomach. Histologically the mucosa is of gastric type. (Histologic study by Dr. B. L. Crawford.) 100×.

lacked the appearances noted in cicatrical stenosis. In several the stenosis was web-like but in the majority the narrowing was more or less funnel-like in appearance varying from 2 to 7 cm. in length. In one case several points of narrowing were noted. Immediately on traversing the point of narrowing the tip of the esophagoscope entered into what appeared to be stomach lined by normal mucosa. In a number of these cases snips of tissue were removed for microscopic examination. The histologic report was gastric mucous membrane (Fig. 9). There was an absence of the normal hiatus oesophageus, in fact, one could not determine when the esophagoscope passed be-

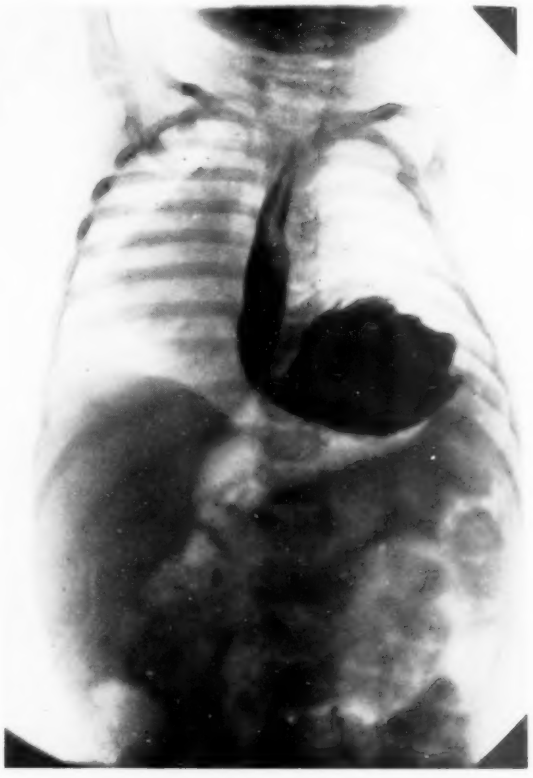

Fig. 10. Note the high position of the left diaphragm and marked displacement of the heart to the right. There is congenital absence of a considerable portion of the anterior bony chest wall on the left side. Note how the esophagus passes through the diaphragm and upward into the cardiac end of the stomach. There was a definite pinchcock effect in this case at the hiatus.

yond the diaphragm level. In a patient who had been gastrostomized because of marked dysphagia this point was carefully investigated by retrograde gastroscopy. Nothing was found to indicate the level of the diaphragm.

Ulceration has been observed in a number of cases. This is usually found at the junction of the esophagus and stomach. In Monkhouse and Montgomery's experience the ulceration observed esophagoscopically

exhibited the appearances of a malignant growth. Haroen and Gerlings[12] reported the occurrence of a congenital short esophagus with partial thoracic stomach complicated by peptic ulceration in a girl aged three years. The ulceration was observed esophagoscopically but no biopsy was performed. Ulceration was observed in 8 of our cases. The extent varied from a small area found at the point of stenosis to extensive changes involving the entire funnel-like narrowing and stenosed lumen. The ulceration appeared superficial, was commonly covered by thin grayish exudate and surrounded by a narrow inflammatory margin. Its edges were not particularly elevated and did not appear indurated. Granulations when present were flat. The appearances were those of an erosion rather than ulceration. This probably explains why the ulceration could not be demonstrated in these cases by roentgen examination.

Variation from the normal in position is best exemplified in cases of complete transposition of the viscera, a condition that is generally considered rare, but so entirely compatible with ordinary customs of living that it may not be recognized until adult life and perhaps not at all. The diagnosis is immediately evident if one looks at the chest or gastrointestinal tract roentgenoscopically.

Eventration of the diaphragm is a relatively common congenital anomaly that is almost never found except by roentgen examination (Fig. 10). In the past it has been confused with diaphragmatic hernia, and, in addition to this, must be differentiated from thoracic stomach, when the stomach is totally in the thorax and the diaphragmatic opening for passage of the alimentary tract is no larger than the normal esophageal hiatus. When the hiatus is of normal size, hiatal hernia is eliminated, and a careful study of the esophagus will show it to have a normal relation with the high diaphragm and will be found to be too short to reach the diaphragm in thoracic stomach. LeWald[21] recommends the lateral view to show the anteroposterior distribution of both halves of the diaphragm to differentiate between hernia and eventration. We recently had a patient with a very high left diaphragm associated with quite marked displacement of the heart into the right chest, as well as absence of a considerable portion of the anterior bony chest wall on the left side. The inner end of the diaphragm was not as high as the costophrenic end, and the barium mixture could be seen passing through a normal hiatus and abdominal portion of the esophagus below the diaphragm.

Another example of variation in position is found in non-rotation of the cecum, where the ascending and even transverse portions may be found in the left upper abdomen, or the transverse portion may be in normal position, with the cecum remaining in the left upper quadrant, or the cecum may be in the right abdomen but pointing upward into the right upper quadrant, a condition known as inverted cecum.[9] These variations are relatively common and assume important rôles in the event of appendicial infection or other infection in the region of the cecum. One must constantly be on the lookout to avoid missing these abnormalities.

Ptosis or abnormal mobility of the alimentary tract is not considered here, even though there may be congenital features.

Adventitious membranes are generally accepted as being present at birth, even though their exact origin may be in question. They do at times produce a high degree of obstruction, especially in the region of the pylorus and duodenum. In one of our cases, almost complete obstruction was produced in this manner. Only a very small quantity of barium passed the first portion of the duodenum in a number of hours. We felt there was a high degree of spasm, or, more probably, hypertrophy of the sphincter. At operation, however, it was found that a relatively small membranous veil or band was causing the obstruction. The operation was entirely successful. Burt and Tyson[3] reported this case and others of a similar character.

These bands or veils, as Cole[6] has termed them, are relatively common and give the same roentgenographic signs as bands of adhesions following inflammatory processes around the gallbladder and duodenum, or at least present difficulties in differential diagnosis, and one would hardly ever recognize the condition without actually making a definite effort to do so.

Lower in the abdomen these veils have been named after certain discoverers. Every roentgenologist has seen cases of Jackson's veil holding the ascending and transverse portions of the colon in contact with each other. Lane's kink, too, has been a familiar term in our literature.

All of these are, of course, extraluminal membranes in contradistinction to those found in the lumen producing more or less obstruction.

Diverticulum, single or multiple, of various parts of the alimentary tract is more commonly acquired than congenital. Every roentgenologist has seen them in the upper end of the esophagus, in the upper small intestines, and in the colon. At the upper end of the esophagus it is held by some authors that congenital diverticulum never exists, but Jackson and Shallow[17] report a case in which a diverticulum of the esophagus perforated into the pleural cavity after a rib resection for empyema. Food particles came through the empyema wound. No roentgen study was made, but at autopsy the diverticulum was discovered and found on close study to have all the coats of a normal esophagus.

There are those who believe that some of the duodenal diverticula are congenital, but we know of no way to differentiate them from the acquired.

There is a diverticulum found more than occasionally, if looked for, in the lower small intestinal tract that is always congenital and frequently associated with, or possibly is directly responsible for, temporary or complete intestinal obstruction. It is called Meckel's diverticulum and is usually found from 12 to 36 inches above the ileocecal valve. It is an extremely serious menace to the patient, is very apt to escape diagnosis, and, in the obstruction cases, the mortality is high. The roentgenologist will find it only after careful study. Pfahler[23] has recently reported 2 cases that were proved surgically.

The diverticula of the colon are probably always acquired.

The important point from the viewpoint of roentgenology in all these congenital variations from the normal is that they can practically always be demonstrated by careful roentgenologic study, but, on the other hand, they will almost invariably be overlooked unless they are actually and intentionally looked for.

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MORTALITY STUDY IN CARCINOMA OF THE UTERINE CERVIX TREATED BY IRRADIATION*

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TREATMENT of carcinoma of the uterine cervix by radium and roentgen rays has proved an efficient means of combatting a very terrible disease. Many radium clinics in this country and abroad have published reports of excellent end-results in large numbers of cases. With increasingly improved technique, results have improved steadily and a great deal has been learned.

We can certainly learn as much, however, by a study of our failures and errors in judgment. The good response of cervical carcinomas to irradiation tends to suppress the fact that we are dealing with an especially malignant form of carcinoma, one that grows rapidly, spreads quickly by extension and distant metastasis, and is always accompanied by infection. Hence, radiologists are to be congratulated on the low mortality rate reported in this group of very advanced cases.

Heyman,[4] in reviewing the world literature on this subject, quoted a mortality rate in treatment of 1 to 2 per cent as the usual experience. With such a low mortality rate, however, the opportunity to profit by post-mortem studies is somewhat limited. In order to assemble enough data to make the present study significant, therefore, an examination was made of the findings at necropsy of patients who died of carcinoma of the uterine cervix at The Mayo Clinic during a ten year period, from 1924 to 1933, inclusive.

The primary mortality rate among 1,117 patients who were treated for carcinoma of the uterine cervix at the Clinic during this ten year period was 1.16 per cent. This accords well with the reports of the eminent radiologist Heyman. At the Radiumhemmet, in Stockholm, during the ten years from 1916 to 1926, Heyman[3] reported that of 1,017 patients treated for this condition, 20 died, a mortality of 1.96 per cent.

Of a total of 25 patients with carcinoma of the uterine cervix who received irradiation with radium or roentgen rays at the Clinic and who died in this ten year period, 13 died during the first course of radiation treatments and 10 died during return visits to the Clinic. The remaining 2 patients died from causes other than carcinoma of the cervix. Necropsy was obtained in 21 of these 25 cases.

Patients who for one reason or another are not treated die mainly from renal insufficiency and uremia, as do those also who are not cured by radiation treatment; although the latter class usually obtain a few years of palliation. Carcinomatous blockage of the ureters as they pass close to the cervix in the base of the broad ligaments leads to hydronephrosis, perhaps to pyonephrosis, and eventually to renal failure. Kelly and Burnam[5] stated, "Probably the most common cause of bilateral hydronephrosis in the female is cancer of the cervix uteri. Almost any intrapelvic growth, especially those in the broad ligaments, may lead to compression of the ureter and consequently hydronephrosis." Many patients die from hemorrhage due to erosion of large pelvic vessels. Many others, cachectic from absorption of toxins from areas of necrosis and weakened by hemorrhages, succumb to terminal infections. One patient died of peritonitis at the Clinic before any treatment was instituted; in this case carcinoma of the cervix was an accidental finding at necropsy. Others die from the effects of distant metastasis. A review

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of the lymphatic system in any standard anatomy[6] will show that the iliac nodes and the hypogastric and sacral nodes often would be involved and, with extension of the growth to the fundus, the lumbar or aortic nodes would also become involved. Later, metastasis is prone to occur to the lungs, bones, and liver; indeed, distant metastasis occurs more frequently than is usually suspected.[2]

In addition to the 25 patients previously mentioned, 2 with carcinoma of the uterine cervix died after having received radiation treatment elsewhere. The first patient died on the day after admission, one treatment with radium having been given ten days previously. Besides obstruction of the ureters and hydronephrosis, this patient had metastasis to the pelvic floor, left ureter, and to the pelvic and aortic lymph nodes. The second patient had radiation treatment elsewhere eight weeks prior to admission to the Clinic; she died of hemorrhages after admission. At post-mortem examination no carcinoma nor evidence of metastasis was found; an extensive ulceration of the vaginal vault was present, however, and the fatal hemorrhage had occurred from the left uterine artery.

Six patients, who had not received radiation treatment, died within a few days of operation (Wertheim's operation or total abdominal hysterectomy in all but one case) from infection and general peritonitis or from shock and hemorrhage. Three other patients with carcinoma of the uterine cervix died following operation; these had received radiation treatment elsewhere. One died following total hysterectomy, death being due to peritonitis and to terminal pneumonia. There was metastasis to the iliac and aortic lymph nodes. A second died following transplantation of the ureters into the sigmoid because of necrosis of the bladder with hydro-ureters; death occurred from peritonitis, pyelonephritis, and bronchopneumonia. No residual carcinoma was found. The third patient died from the same causes as the second, following repair of rectovaginal and vesicovaginal fistulas. Again no carcinoma was found at post-mortem examination.

Seven patients with carcinoma of the cervix died following major surgical procedures for palliative purposes. Radium and roentgen rays had previously been employed at the Clinic. In 1 case the operation was cordotomy for pain, in 2 cases exploratory laparotomy, and, in 2 others, nephrostomy. The post-mortem findings were of great interest in 2 cases. In 1 case treatment with roentgen rays had been given eight months previously. The patient had returned to the Clinic with a painful mass in the right upper abdominal quadrant and an exploratory operation was performed. She died eight days after operation of a terminal bronchopneumonia and, at necropsy, extensive metastasis to the liver was found; however, there was no residual carcinoma of the pelvis. The second case was even more remarkable. Treated two years previously with radium and roentgen rays for inoperable carcinoma of the cervix, a squamous cell epithelioma of grade 2, the patient returned to the Clinic with an acute abdominal condition (Fig. 1).

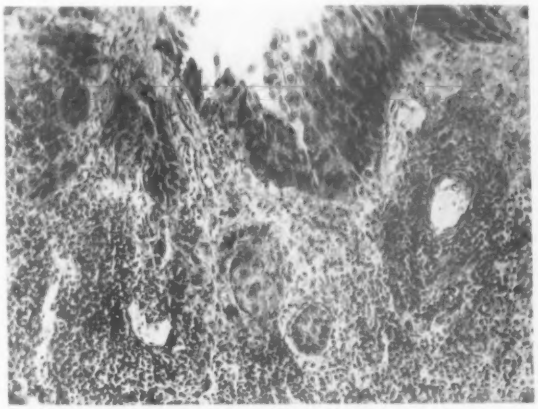

Fig. 1. Specimen for biopsy obtained before radiation treatment (×150). The diagnosis was squamous cell epithelioma, grade 2. The patient had extensive carcinoma of the uterine cervix with annular infiltration of the vaginal wall and transverse infiltration of the broad ligaments. She died two years after radiation treatment following an operation for appendicial abscess. At necropsy neither residual carcinoma nor evidence of metastasis was found.

Drainage of an appendicial abscess was carried out but the patient died twenty-four days later of pulmonary embolus. At necropsy, no evidence of carcinoma was found in the pelvis and there was no evidence of metastasis.

One of the 2 patients treated by irradiation at the Clinic who died later of causes unrelated to carcinoma had an inoperable carcinoma of the cervix, a squamous cell epithelioma of grade 4; her death was due to cerebral infarction. Besides cerebral arteriosclerosis and infarction of the right cerebral hemisphere, necropsy revealed no evidence of residual carcinoma of the cervix, although carcinomatous cells were found in the aortic lymph nodes. The other patient, who had been treated seven years previously for inoperable cancer of the cervix, a squamous cell epithelioma of grade 3, returned with nausea, diarrhea, and jaundice, and with a history of having taken large doses of a proprietary brand of cinchophen (atophan) for a neurologic condition. She died in a few days despite all supportive measures, and post-mortem findings revealed subacute yellow atrophy of the liver. No carcinoma was found locally and there was no evidence of metastasis (Fig. 2).

FIG. 2. Specimen for biopsy obtained before radiation treatment (×100). The diagnosis was squamous cell epithelioma, grade 3. The patient had an extensive carcinoma of the cervix with involvement of the vaginal wall and extension into both broad ligaments. She died of acute yellow atrophy of the liver seven years after radiation treatment. At necropsy, neither residual carcinoma nor evidence of metastasis was found.

Of the 13 cases in which patients with carcinoma of the cervix died during the first course of radiation treatments at the Clinic, necropsy was obtained in 11 cases. As practically all cases, no matter how desperate the condition of the patient, are accepted for radiation treatment with a view at least toward possible palliation, some deaths may be expected to occur during the period in which radium or roentgen rays are applied, or indeed during any form of treatment or of manipulation. The humanitarian training of the physician and the importunities of the sufferer's relatives often overbalance radiologic judgment, so that treatment may be pushed beyond the limits of the patient's strength and complications may often ensue which prove too severe a drain on her stamina. To minimize this unfortunate occurrence it is advisable to study each patient quite exhaustively before instituting treatment. Besides a careful, general physical examination, thorough laboratory studies should be made. If catheterized specimens of urine reveal pus and blood, cystoscopic examination and determinations of blood urea should be performed. Careful hematologic studies are essential, and roentgenograms of the thorax and pelvis are helpful. Necrotic portions of the primary carcinoma should be cleared up as far as possible, and the general health of the patient must be supported. Although on superficial examination the general health may appear good, these patients must be handled most cautiously. There are many dangers, and serious complications may supervene at any time. However, risks must be run if these patients are to be treated effectively. In applying radium in the cervical canal and fundus of the uterus, long-standing pelvic infections must be disregarded, in contrast to the procedure in cases in which a tumor is benign. A decided advantage of the broken-dose method of treatment is that, on the advent of any serious complication, such as hyperpyrexia, beginning pelvic abscess, or evi-

dence of uremia, treatment can immediately be abandoned and all efforts made to combat the complication.

All these 13 patients had advanced, inoperable carcinomas and in each instance complications arose during treatment which caused abandonment of irradiation and the use of all possible supportive measures, but without avail. Of the 11 cases which came to necropsy, biopsy had been made in all but one case; in this case the lesion had been modified by radiation treatment elsewhere, three months before, with superficial healing, and to have obtained a specimen for biopsy would have necessitated incision through barriers of normal tissue. In the other 10 cases, adenocarcinoma was found at biopsy in 2, a mixture of adenocarcinoma and squamous cell epithelioma of grade 4 in 1, squamous cell epithelioma of grade 4 in 6, and squamous cell epithelioma of grade 3 in one. This conforms to experience at The Mayo Clinic previously reported for a large series of cases.[1] In that report specimens at biopsy were predominantly squamous cell epitheliomas, the large majority of which were of grades 3 and 4.

The 10 patients who died on return visits to the Clinic had previously been treated with radium and roentgen rays with much palliation. Three of them lived in the city and died at their homes. Necropsy was obtained in 8 of the 10 cases. In 1 of these cases, in which the patient had received radiation treatment two months previously, no residual carcinoma remained in the pelvis although carcinomatous cells were found in the aortic lymph nodes.

Logically, in comparing the group of 13 patients who died during the first course of radiation treatments with the group of 10 who died at subsequent visits to the Clinic, or at their homes (in 3 cases), one would consider the former group to consist of patients with the earlier, less advanced form of the disease. The patients in the second group passed away from several months to several years following treatment; in 3 cases between six and seven years after the initial course. Patients in this second group had not been cured, but palliation had been effected and they had returned for examination and occasional limited treatment.

From the foregoing one would expect to find a higher incidence of pelvic cellulitis, general peritonitis, septicemia, and terminal pneumonia among patients in the first group, and a higher incidence of obstructed ureters with hydronephrosis, metastasis to lymph nodes, distant metastasis, and fistulas among those in the second. The actual findings are shown in Table 1. These deductions are upheld until the last two headings are reached, when such reasoning is completely discredited. It is surprising to find an equal number of patients with metastasis to the lymph nodes in the first and second groups; it is even more surprising to find a higher incidence of distant metastasis among patients in the first group than in the second. In Table 11 it will be seen that 5 patients in the first group were found to have carcinoma of the lungs against 1 in the second. In these cases the metastatic lesion in the lung was small and its presence was unsuspected before radiation treatment was begun. There had been no pulmonary symptoms. Roentgenograms of the thorax were not taken in 2 cases,

TABLE I

FINDINGS AT NECROPSY OF PATIENTS WHO DIED DURING FIRST OR SUBSEQUENT VISITS TO THE CLINIC

Findings at necropsy	Group 1	Group 2
	Died during first visit*	Died during subsequent visits†
Peritonitis	7	1
Septicemia	4	0
Terminal pneumonia	3	2
Hydronephrosis	2	6
Fistulas	0	3
Metastasis to lymph nodes	6	6
Distant metastasis	5	2

* Necropsy obtained in 11 of the 13 cases.
† Necropsy obtained in 8 of the 10 cases.

TABLE II

DISTANT METASTASIS AMONG PATIENTS WHO DIED DURING FIRST OR SUBSEQUENT VISITS TO THE CLINIC

	Group 1	Group 2
Metastasis to:	Died during first visit*	Died during subsequent visits†
Lungs	5	1
Liver	2	1
Kidneys	1	0
Ileum and peritoneum	0	1

* Metastasis was present in 5 of the 11 cases which came to necropsy.

† Metastasis was present in 2 of the 8 cases which came to necropsy.

gave negative results in 2 cases, and revealed hydrothorax on the left side in 1 case. Only 1 patient in the second group had pulmonary metastasis. There were 2 patients in the first group with metastatic lesions in the liver contrasted with 1 in the second group, and 1 patient in the first group with involvement of the kidneys contrasted with none in the second group. In other words 5 patients in the first group who died during radiation treatments, presumably in the early stages of the disease, revealed beginning carcinomatosis contrasted with 2 patients in the second group.

We must conclude, therefore, that the presumably "early" group in which patients died during their initial treatment, was in reality the more advanced group in the sense of widespread dissemination of malignancy. This can be explained by two additional factors: in the first group treatment by irradiation had been abandoned early, at the onset of complications and before sufficient dosage had been given and sufficient time had elapsed to have altered the malignant process appreciably. Two to three months must elapse following a course of radiation treatment before changes in tissue due to treatment are completed. In the second group all but 2 of the patients died eventually of the carcinoma (1 died from infection, carcinomatous cells being found in the lymph nodes and another died of uncontrollable hemorrhages), but the malignant process had evidently been favorably influenced by the treatment and arrested for a considerable period of time before death occurred.

In addition to the 5 patients with distant metastasis, there was a sixth with metastasis to the lymph nodes. Thus 6 of the 11 patients were in a hopeless condition from any standpoint. They apparently offered no resistance whatever to the malignant process and fell an easy prey to infection. I feel that these patients would have succumbed under any form of treatment, even a medical regimen.

COMMENT

That advanced inoperable carcinoma of the uterine cervix can sometimes be cured by treatment with radium and roentgen rays is proved by the 2 cases cited, in 1 of which the patient died following operation for appendicial abscess two years after radiation treatment, and the other in which the patient succumbed to subacute yellow atrophy of the liver seven years after such treatment. Neither residual carcinoma nor evidence of metastasis could be found in these cases. This is not a new observation, but it is rather a rare one considering the fact that the carcinoma was advanced and inoperable.

That irradiation is a local treatment and can only cure if metastasis has not already occurred is demonstrated by the case in which the patient died of metastatic complications in the liver, the pelvic carcinoma having cleared up completely as a result of radiation treatment. This is likewise illustrated by the case in which the patient died of cerebral infarction; no residual pelvic carcinoma remained, but there was evidence of carcinoma in the aortic nodes. In 1 case in the second group no pelvic carcinoma remained, although there was metastasis to the lymph nodes.

SUMMARY AND CONCLUSIONS

Of the 1,117 patients who were treated by radium and roentgen rays at The Mayo

Clinic from 1924 to 1933, inclusive, for carcinoma of the uterine cervix, 13 died during the primary course of treatment. The primary mortality rate, therefore, was 1.16 per cent.

Comparison of findings at necropsy of patients who died during the first course of treatment and of those who died during subsequent visits disclosed that acute pelvic infection and hemolytic streptococcal septicemia accounted for most of the deaths in the first group. A rather unexpected finding, however, was that there were as many patients with metastasis to the lymph nodes in the first group as in the second, and that there was a greater number with distant metastasis in the first group than in the second. Distant metastasis occurred mainly to the lungs and to the liver. These distant metastastic lesions were unsuspected and by our present clinical methods were undiscoverable.

The deductions which can be made from analysis of this small group of patients who died during treatment by irradiation are three-fold: (1) The prognosis in every case accepted for treatment must be very guarded. The relatives must be instructed that distressing complications may occur and that these complications often terminate fatally, even though the patient appears on superficial examination to be in good general health. The possibility of a serious complication must always be kept in mind. (2) The best method of keeping the mortality rate as low as possible is by thorough study of each individual case and, with suspicion of metastatic involvement or of impaired renal function, to limit treatment so as not to place undue stress on the patient. Such patients should be treated for palliation rather than for cure. (3) The broken-dose method of treatment seems preferable to the massive dose technique; the effect appears to be gentler and more gradual and, on the appearance of any serious complication, irradiation may be instantly abandoned. By careful nursing and supportive measures, many of these unfortunate patients may be saved.

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DISCUSSION

Dr. Henry J. Walton, Baltimore, Md. The frequent occurrence of carcinoma of the cervix, its accessibility to the application of radium, and the comparative ease with which massive doses of short roentgen rays can be concentrated in the cervix, has made cancer in this region vulnerable to attack, and recent publications contain many statistics which are remarkably uniform where similar methods of treatment are employed.

Dr. Fricke's analysis of deaths among 1,117 cases of carcinoma of the cervix at the Mayo Clinic, and the result of the autopsies seem to justify the assumption that carcinoma of the cervix is a curable disease. It appears that even in advanced inoperable cases with metastases, the local lesion can often be entirely eradicated by irradiation, but a cure cannot be expected if metastasis has already extended beyond the cervix at the time of treatment. Patients with extensive infections and advanced metastases are bad risks and the mortality following any line of treatment is sure to be high, irrespective of the location of the primary lesion.

In our oncology clinic at the University of Maryland, Dr. Hundley has had 2 primary

deaths in 125 cases of carcinoma of the cervix (1.6 per cent). The first was a woman thirty-five years of age, referred for irradiation following an operation on the cervix at another hospital. She was given an intra and contra application of radium, but died forty-eight hours later of general peritonitis. Autopsy showed an ulcerated cervix due to surgical cauterization, the cavity of the uterus was covered with a thick, greenish, fibrinous deposit, and the pelvis and abdomen were filled with a thin greenish fluid.

The second case was a woman who had an extensive squamous cell carcinoma of the cervix with metastasis, type 3. She was given two applications of radium, 3,000 mg-hr. each. Following the second application, she developed a tender fluctuating mass in the suprapubic region which was thought to be pyometra. The cervix was dilated, but no pus escaped. Under anesthesia, a posterior colpotomy was performed, and a cloudy fluid escaped through the pelvis. The patient was in such poor condition that a laparotomy was not possible, and she died the following day. Autopsy showed a ruptured tubo-ovarian abscess with free pus in the abdominal cavity. The cervix showed almost complete recession of the growth, but metastasis was present.

We feel that if both of these patients had first been given deep roentgen treatment, and radium applied later, the result in at least one of them might have been different.

Our present method is to use the roentgen ray first; this is followed by the local application of radium, and six weeks later, a second series of roentgen treatments is given.

It is often very difficult to know what to do in regard to the treatment of many of these advanced and hopeless cases of carcinoma. We have all seen patients with far advanced malignancy respond miraculously to the effect of irradiation, and many of these unfortunates are temporarily benefited. It therefore becomes our duty to do what we can to relieve them.

As the mortality from roentgen irradiation per se is practically nil (especially if the divided dose method is employed), most of the advanced cases are now being referred immediately for roentgen therapy. I feel that until it is possible to have patients with cancer referred earlier for treatment, many of our departments of oncology are going to be crowded, so to speak, with cases for which we can hope to do very little, a certain number of whom may be expected to die, either during, or shortly after, treatment.

Dr. FRICKE (closing). As to our dosage, we start usually with the radium treatment and give, with a complete treatment, a total of about 7,000 to 8,000 mc-hr. over a period of about three weeks, and this is followed by a series of treatments with roentgen rays, 200 kv. in the pelvic region, four or five treatments in all, given one each day for four or five days. Then, on one return visit, after three months, the series of treatments by roentgen rays is repeated, but no further treatment is given after that unless recurrence takes place, or unless the growth does not respond.

Of course, if distant metastatic growths are discoverable clinically, or if renal function is seriously impaired, only a limited treatment is outlined, with palliation in view. Palliation usually is achieved in these perfectly hopeless cases; pain is relieved, bleeding and offensive discharges are stopped, and life is prolonged with fair comfort, for a considerable time.

RADIUM IN THE TREATMENT OF METASTATIC EPIDERMOID CARCINOMA OF THE CERVICAL LYMPH NODES*

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THE present discussion is not intended to embrace a full consideration of the treatment of metastatic cancer in the cervical lymph nodes. The meeting is one devoted primarily to a consideration of radium problems. Technical factors are to be stressed especially. The subject is further limited to the neck and excludes the treatment of the primary growth within the mouth.

The general plan and principles involved in dealing with the cervical lymphatics, as followed by me during the past eighteen years, have been published upon various occasions. For the purpose of continuity a brief outline only will be given.

All cases of upper mucous membrane tract cancer acceptable for treatment receive roentgen therapy as a preliminary measure. The factors and technique of this therapy are steadily changing in keeping with the general progress in roentgen therapy. No effort, therefore, is being made to present details, other than to state that the treatment is adjusted to give an intense erythema to both sides of the neck, at the end of a period of two to three weeks. The intensity is carried to such point that superficial scaling occurs as the reaction subsides. It is not carried, however, to the point of superficial destruction of skin.

Necks presenting no palpably metastatic lymph nodes receive no further treatment.

Surgical dissection of the neck, when done, is unilateral but the most radical possible. Dissection is limited to fully differentiated epidermoid carcinoma, palpable involvement unilateral, capsule of the node or nodes presumably intact, in patients presenting good general physical condition and in whom the primary growth is either controlled or gives promise of complete controllability.

The strictly anaplastic, or totally undifferentiated, growths are left to roentgen therapy alone. Caution must be exercised, however, in the total lack of undifferentiation. It is only in the totally anaplastic, or most radiosensitivet ype of growth, that the metastatic node may be reasonably trusted to external therapy only. Extremely advanced metastatic involvements, particularly where the primary growth is far advanced or out of hand, and regardless of the histologic type, are left to roentgen therapy for whatever palliation is obtainable.

Under all other circumstances interstitial irradiation is employed, following the initial roentgen therapy. When we consider the narrow limits which we have placed on dissection it at once becomes apparent how diverse are the conditions in which implantation must be employed. There are many metastatic node problems between the palpably uninvolved neck and those suitable, histologically and anatomically, for surgical dissection. Implantation with radon or radium element should not be resorted to for interim or expected short-term palliation. This is a problem for external irradiation. Interstitial irradiation should aim at "cure" or long-time palliation.

Allow me to stress once more the usage of roentgen irradiation as a preliminary measure in all cases regardless of whether or not grossly demonstrable node involvement is present. The gradual lowering in percentage of cases developing nodes after admission (when admitted free from palpable nodes) is a tribute to the steadily increasing efficiency of external therapy as a preventive measure. Efficiency of roentgen therapy is rapidly increasing for many reasons which need not here be enumer-

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ated. In my opinion, it is preferable to radium for external therapy unless such external radium therapy be carried out with large quantities of radium at considerable distance from skin surfaces.

Teleradium therapy which we might accept as superior to roentgen therapy would require an amount of radium sufficient to produce comparable skin reactions, over a two to three weeks' period at a distance of 10 to 15 cm. Such teleradium therapy is impractical and economically impossible, except in a very few cases. Acknowledgment, however, must be made of the possibility of real value for radium at shorter skin distances if continuous application be made over a prolonged period such as two to three weeks.

It becomes apparent, therefore, from a practical standpoint, in my opinion, that the applicability of radium in the cervical node problem is limited to interstitial irradiation.

In Which Cases is Interstitial Irradiation Indicated? From the histologic point of view, it is indicated in all cases except the extreme Grade IV group, unless the case falls in the limited group for surgical dissection, or, on the other hand, be extremely advanced. Some even of the Grade IV, or totally anaplastic group, are liable to renewed growth activity a few months after a seeming complete regression following external therapy. Implantation, therefore, is of real value even in some of these cases. Regardless of the histology, and excluding again the extremely advanced group, implantation is indicated in all cases with invasion of the node capsule, as evidenced by the palpable fixation of the node, in all cases of bilateral involvements, and in all recurrent cases. The general physical condition of the patient is a determining factor. In certain instances, the neck which is histologically and anatomically suited to dissection may be an extra hazardous risk because of serious chronic constitutional disease. Age alone is not a contraindication to radical surgery but the chronic constitutional degenerative changes attendant upon advanced age are usually such as to preclude it. Implantation is safer under such circumstances.

In What Form Should Radium be Used? My preference is strongly for radon seeds. The wide range of usefulness of radon seeds and their flexibility of application has been stressed many times. In conjunction with neck surgery they have an added advantage in that they may be used without in any way complicating perfect operative surgical technique. In necks heavily irradiated by external therapy as a preliminary, and with surgery done in conjunction with further irradiation, primary healing of the surgical wound is an extremely important factor. The utmost in careful surgical technique is essential if primary healing is to be assured.

The present type of radon seed employed (0.3 mm. gold filter) sacrifices somewhat in filtration for its many advantages. The element needles usually employed have an advantage in filtration, but the necessity for their withdrawal at a time when surgical wound healing is well under way is a considerable disadvantage. The trauma at this time is apt to be substantial. Under no circumstances is it possible to employ them for as prolonged irradiation as is possible with the radon seeds. However, element needles are available in many places where the radon seed is not readily obtainable, hence, they represent an excellent and effective second choice for implantation.

There is another means of interstitial irradiation with a limited range of applicability, somewhat comparable to intracavity irradiation, yet extremely valuable under certain circumstances. A limited area of involvement with extreme central liquefaction may be encountered unexpectedly, or a neck may be opened for some purpose other than primarily implantation, in a case where the odds are in favor of probable metastatic involvement. Under such and similar circumstances a pure gum rubber drainage tube not more than 1 cm. in diameter may be inserted to the furthermost point of the wound, sutured in place lightly

and the wound closed. Following this, a heavily filtered tube, or series of tubes, carrying radon or radium element may be passed into the central axis of the questionable area through this larger tube in much the same manner as employed in the introduction of radium through the cervical canal and into the fundus of the uterus. If a single radium tube only is employed it can be moved downward from day to day through the outer casing, thus obtaining uniform distribution. A series of tubes, however, of proper length are obviously preferable because more prolonged irradiation is then possible. Care should be taken to avoid imposing too far on the strictly surgical condition of the wound by keeping the large rubber tube in place for too long a period (four to five days at most).

No matter for what reason the neck has been opened surgically in a case of mouth cancer, advantage of this exposure should always be taken to provide interstitial irradiation in some form. It is the most effective means of irradiating the most dangerous areas of the neck and no opportunity should be lost to take advantage of it.

Interstitial irradiation of cervical nodes always presupposes surgical exposure. It is not possible to make accurate placement of seeds or needles through skin puncture if the case is one suitable for interstitial irradiation. If reasonably accurate distribution can be made through skin puncture, the disease is too far advanced for treatment by implantation. It should be left to external therapy as a palliative procedure.

A few points relative to surgical technique should be stressed. Local anesthesia is always preferred to general anesthesia. Tissues are handled more gently and the cooperation of the patient is a distinct advantage. Care should be taken in the skin preparation. Tincture of iodine is apt to produce irritation. Five per cent picric acid in alcohol is, in my experience, much more acceptable to the previously irradiated skin. Surgical exposure for implantation should of course be delayed until acute reaction from external irradiation has subsided. The amount of dissection done for exposure of the node or nodes to be implanted should be as limited as possible consistent with accuracy and thoroughness. Meddlesome dissection for the purpose of surgical display serves no end other than to interfere with the blood supply.

If any question exists as to central liquefaction of the involved node, it should be aspirated with a large needle. If extensive liquefaction is evident, a frank evacuation of the centrally liquefied contents of the node is indicated. This violates a cardinal principle in cancer surgery by cutting through a layer of tumor tissue. It is, however, the lesser of two evils. Liquefied débris, whether or not infected, contributes in great measure to untoward inflammatory reactions following implantation, and should be drained wherever possible.

If a node capsule is incised for drainage, the cavity should be lightly packed with iodoform gauze, the free end of which is brought out of the wound at its most dependent point, or through a separate drainage opening. Gradual withdrawal of this over an interval of three or four days will avoid further trouble through a prolonged outpouring of serum. At the time of surgical exposure the possibility of any other procedure should always be carried in mind, chiefly ligations of the external carotid, or placement of radon for the purpose of irradiating the base of a primary growth in the hypopharynx.

Interstitial Radium Dosage. It is impossible to give a set of rules or directions for dosage in interstitial radium or radon application. The variable factors are too many. Decisions must be governed largely by experience, taking into account the various factors of influence. It is safe to say that the intensity should always be carried to the limit of normal tissue tolerance, in spite of the suggested radiosensitivity if the growth tends to be anaplastic. The intensity of the irradiation should be dis-

tributed over a zone well beyond the gross limits of involvement. Certain limits of minimum and maximum intensity might be stated as an empiric guide. I should regard 3,000 mc-hr. of radon irradiation, or its equivalent in element, as representing a fair minimum, and an amount which should be used if implantation is to be employed at all, even though the particular node in question does not itself call for so large an amount. The tumor bed will tolerate it well in most positions in the neck and the wider zone of irradiation is an added factor of safety.

While I have at times employed more than 10,000 mc-hr. in one side of the neck, I should nevertheless regard that amount as a fair maximum. Reference to standard tables of dosage measurements will at once indicate that 10,000 mc-hr. represents approximately a dosage intensity of 10 S.E.D. to a tumor mass 5 cm. in diameter, or 6 S.E.D. to a mass ranging from 6 to 7 cm. in diameter.

Since these intensities represent the safe limits for complete controllability of the average epidermoid carcinoma, except the totally anaplastic type, it at once defines approximately the maximum size of the metastatic mass which may be controlled completely, and with safety, by interstitial irradiation. The upper limit in size suitable for treatment by interstitial irradiation, with a variation depending somewhat upon the histology, ranges from 5 to 7 cm. in diameter at the utmost.

In attempting to make comparable calculations as between radon and radium element needles, due allowance should be made for the time factor. With needles, the total period of irradiation is either of necessity or probability substantially shorter than with radon seeds. At the present time radon seeds, as previously stated, are of 0.3 mm. gold filter with a tendency toward increasing this filter. The strength of individual seeds is dependent somewhat upon the size of the mass to be treated. In my experience, quantity per seed has varied from 1 to 2 mc. Preference is for the weaker seed. Practical considerations in caring for the larger mass demand the stronger seed.

Major Factors of Influence in the Individual Case. The influence of histology has already been referred to. Emphasis, however, should again be laid on the inadvisability of trusting too much to external therapy only, in grossly involved anaplastic nodes. Wherever interstitial irradiation can be added reasonably it is a very worthwhile safeguard. Attention is again called to the influence of the primary or recurrent character of the growth. The recurrent node, no matter if the involvement be unilateral and the capsule intact, is still a problem for implantation rather than further resort to surgical extirpation. The metastatic node with invaded capsule, even though it be very small, and technically removable by dissection with adjacent structures, is again an implantation problem rather than one for surgical removal. The same is true of bilateral nodes under any circumstances.

Where primary growth control is decidedly uncertain, the advisability of interstitial therapy is usually doubtful. The general condition of the patient is a determining factor which has previously been discussed, but a factor of sufficient importance to warrant repetition. In connection with the generally poor surgical risk, but with an otherwise "operable" neck, a rather nice point for decision occasionally arises. Are we at any time justified in removing the small metastatic node with intact capsule and implanting the node bed as though the node were still present? I am inclined to believe that occasionally we are justified. Still it is a very dangerous procedure to advise, and should not be followed as a routine by any means. It is a distinction which may be made to advantage occasionally by the surgeon of wide experience in dealing with this generally complicated problem.

The anatomic relationships of the seeds or needles implanted are at times important. Since the filtration is at all times

substantial, it is surprising how closely the great vessels may be approached without damage. Nerves are scarcely as tolerant as are the vessels. A substantial amount of fat padding about the nerves permits of a very close approximation of the seed or needle without damage, providing the area is not frankly overdosed. Overdosage does not of necessity imply local necrosis of tissue. The reaction which is evidenced by a very prolonged and persistent brawny infiltration, and which is most frequently noted in fat necks, must be regarded as an overdosage even though not accompanied by gross focal necrosis of tissue. Considering the sites of most implantations, such reactions cause most trouble through pressure about and irritation of the second, third and fourth posterior cervical sensory roots, the spinal accessory nerve and the main trunks of the brachial plexus in the lower part of the neck. Likewise, the sympathetic plexuses of the neck may through overdosage be stimulated to the production of various unpleasant symptoms.

Care should be taken always to temper the dose if the implantation be closely approximated to the submaxillary salivary gland, or the lower pole of the parotid salivary gland. These structures have a complex drainage system, and if overirradiated are apt to remain chronically inflamed and painful for several months. With reasonable caution, however, this is avoidable. There is little danger of damage to the laryngeal cartilages through implantation of metastatic nodes. The involved nodes are usually sufficiently removed, or at most overlap only the posterior border of the lateral ala of thyroid cartilage.

The presence of scar tissue always demands a lessening of the dosage intensity. Repeated treatments likewise must be guarded in intensity because of the possible damage to skin or underlying tissue of a previously implanted area. Repetition of interstitial irradiation in any one single area is distinctly contraindicated. If the initial implantation has failed for any reason (usually insufficient dosage) it is then too late to retrieve the situation by a second implantation.

In the interstitial irradiation of metastatic cervical nodes, the coexistence of syphilitic infection does not bear the same importance as it does in the treatment of certain of the primary growths within the mouth, particularly the tongue. So far as the neck is concerned, its adverse influence is that of a chronic constitutional disease only.

Finally, the influence of infection cannot be featured too strongly. In the presence of active infection in the metastatic lymph node, irradiation by implantation is at all times contraindicated. The local response to such irradiation is so discounted that growth control need not be expected. Furthermore, the lowering of vitality and resistance in the surrounding tumor bed by the irradiation favors and encourages more widespread extension of the infection. The failure of surgical wound healing is obvious. Even with no gross infection in the neck, the presence of an infected growth in the mouth is a contraindication to implantation until that infection is cleared up within the mouth, and until whatever influence it has had upon the cervical lymphatics has had sufficient time to subside.

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RADIUM DOSAGE AND TECHNIQUE IN CARCINOMA OF THE SKIN

WITH SPECIAL REFERENCE TO INTERSTITIAL IRRADIATION WITH PLATINUM IRIDIUM NEEDLES*

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IN A previous publication[3] we have described the various methods employed by us in the treatment of carcinoma of the skin and mucous membranes. In the present communication we propose to deal primarily with technique and dosage in the use of platinum iridium needles containing small amounts of radium for prolonged interstitial irradiation of certain selected cases of skin malignancy. It is not the purpose of this paper to discuss the problems of carcinoma of the lips and mouth, in which we have found the method also valuable. The use of this method has been strongly advocated by Martin,[8] Lenz,[7] Soiland,[11] Kaplan,[6] and others in this country, but particularly in the treatment of skin carcinoma it has apparently been little used. The original work of Regaud[10] and associates at the Radium Foundation of Paris, and of Bayet[1] and associates at the Radium Institute of Brussels paved the way for the development of the present type of small radium needles by the British radiotherapists, Evans and Cade,[4] Birkett,[2] Fitzwilliams[5] and associates. In Europe, this method, because of the superior results obtained, has largely replaced the use of radon seeds for interstitial irradiation. Regaud[10] prefers the use of radon in heavily filtered platinum needles, that are later removed, to the radium element needles.

DESCRIPTION OF NEEDLES

The platinum iridium needles used by us are of the French-British type and contain 1, 2 or 3 mg. of radium element. They are 27 mm., 44 mm. and 60 mm. in length respectively, so that appropriate sizes can be chosen, according to the size of the tumor which is to be irradiated. The radium is contained in cells 15 mm. in length, containing 1 mg. each of radium. In the longer needles these cells are placed end to end in the hollow needle so that a continuous radiating focus of equal strength per running centimeter is formed. The diameter of each needle is 1.65 mm. with a wall thickness of 0.5 mm., sufficient to filter out nearly all beta rays. Each is equipped with an iridium trocar point and the other end is closed by an eyed stopper to which silk sutures are attached for holding them in place and facilitating their removal.

Specially constructed forceps and pushers are used for holding the needles rigidly so that they may be accurately directed during their introduction into the tissues.

TECHNICAL FACTORS

The size and shape of the lesion to be treated will determine the sizes of the needles to be selected in any given case. Providing the tumor is not too large, we have found that a parallel arrangement of the needles is usually preferable. However, in larger growths they can be arranged radially like the spokes of a wheel. They are inserted through the normal skin and through or under the tumor, or both, depending on its size. Introduced from opposite sides, the attached braided silk sutures are tied together in pairs, which holds them securely in place. The silk sutures, after being threaded and before using, are soaked in a 5 per cent solution of acriflavin to prevent their digestion in the

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tissues. After all the needles have been secured, the loose ends of all the sutures are gathered together and attached to the skin at some distance by means of adhesive tape. A vaseline gauze dressing is applied and the area cleansed and redressed daily. The entire procedure is carried out under strict aseptic precautions and usually under local anesthesia. It is important to determine the infiltration and mark the extent of the lesion at its borders before the injection of the anesthetic, for swelling thus produced may mask its true outline.

The calculation of dosage is comparatively simple for it is found that needles so constructed will destroy 1 c.c. of squamous cell carcinoma per running centimeter of active radiating focus in seven days. Thus, a 2 mg. needle which contains 3 cm. of radiating length will destroy 3 c.c. of such a tumor in one week. An attempt, therefore, is made to place the needles 1 cm. apart. In basal cell carcinoma the time required to cause complete disappearance is from four to five days. Since longer use causes no apparent damage to normal tissues, it is our custom to leave the needles in place from seven to ten days, depending upon the pathology. So spaced, each cubic centimeter of tissue will receive 116 mg-hr. in seven days, and an exposure of ten days will give 160 mg-hr. Compared with the usual surface applications of radium, this dosage would be considered moderate. A biopsy is taken before, or at the time the treatment is instituted.

Rarely is there any discomfort experienced by the patient while the needles are in the tissues, and their removal is quite painless. Due to a microscopic sleeve of necrosis immediately surrounding the needles, possibly caused by secondary beta radiation, they are loosened and slip out with slight traction on the sutures. The small holes in the skin at the sites of introduction heal promptly and almost completely disappear after a few months.

At the end of about one week after the treatment is begun, the overlying skin becomes a deep red or purple and by about the tenth day vesiculation may be present. This is followed a few days later by exfoliation of the epidermis, which leaves a moist pinkish or red glistening surface covered by an adherent yellowish fibrinous exudate. This reaction has been described by Regaud[10] as "acute selective radiodermatitis," and is considered as an index of proper dosage. Ulceration with crusting often requiring many weeks or months to heal, sometimes seen following surface applications of comparable doses of radium, is rarely seen and when it does occur is due to overdosage.

Healing requires from three to six weeks, depending upon the length of the treatment. The resulting scar after a few weeks becomes soft and healthy in appearance, and even after large lesions have been removed there is little or no deformity.

Failures result, as a rule, not from insufficient dosage, but from inadequate recognition of the extent of the tumor.

ADVANTAGES OVER OTHER METHODS OF USING RADIUM

In the treatment of skin malignancies radium may also be used by surface applications, using various thicknesses and types of filters and at varying distances from the skin. The advantages, however, of interstitial irradiation with the small platinum needles include:

(1) Homogeneous irradiation of the entire malignant area.

(2) Continuous treatment over a prolonged period, having the advantage of irradiating the tumor cells during the successive periods of mitotic division, at which time they show the greatest radiosensitivity.

(3) A single continuous treatment, avoiding the development of radioresistance.

(4) Absence of severe caustic reactions on the skin, followed by necrosis and sloughing, requiring weeks or months to heal, such as is sometimes seen following strong doses of surface irradiation.

(5) As a rule, no demonstrable complications when the radium puncture method has been used over bony prominences or about the eyeball and cartilages of the eye, ear and nose.

(7) Findings that radium puncture by this method can often be employed with success in recurrences following the failure of previous surface irradiation from radium and roentgen rays, which ordinarily

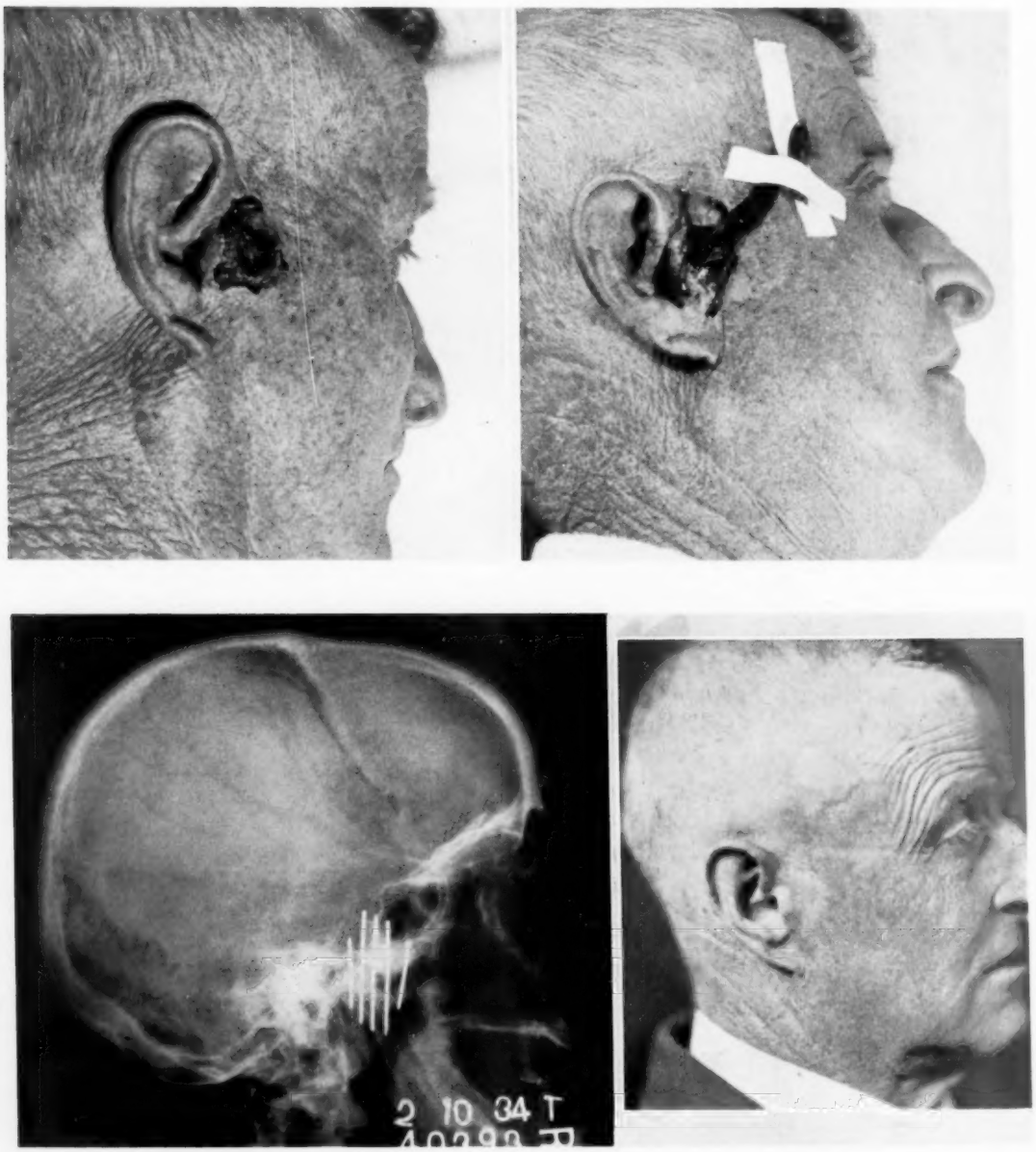

Fig. 1. Squamous cell carcinoma of fifteen months' duration. Had recurred after partial regression resulting from roentgen treatment. Treated February 5 to 13, 1934, by interstitial irradiation with heavily filtered small intensity radium needles. A total of 8 mg. of radium was used for eight days, giving a total dose of 1,520 mg-hr. The last view, taken three months after treatment, shows complete healing.

(6) The important advantage of carefully and accurately calculating the dose. would seem to contraindicate the use of further irradiation of any kind. Moreover,

cancer cells lodged in scar tissue respond better to this type of prolonged gamma-ray irradiation.

(8) The advantages, with greater filtration and constant intensity of radiation, of such needles over the gold radon seeds, and, in addition, the needles are removed at the end of the treatment period, while the seeds remain as foreign bodies.

(9) The possibility of treating even extensive areas of malignancy that would otherwise be most difficult to handle through external irradiation alone.

INDICATIONS

The choice of cases to be treated by this method of implantation therapy in skin carcinoma is governed by varying factors. In general, it is practical and superior to other forms of treatment in extensive malignancies which would be difficult to treat by any method. In other instances the choice is made because of anatomical considerations such as the proximity to bone and cartilage, or because of the character of the underlying integument. Also, the failure of other methods resulting in the presence of considerable scar tissue often determines its use.

FIG. 2. Baso-squamous cell carcinoma. Was uncontrolled by roentgen treatment given previously. Treated in March, 1932, by interstitial irradiation with low intensity radium needles heavily filtered. Dosage: 3,744 mg-hr. in nine days, using four 3 mg. and two 2 mg. needles.

We agree with Quick[9] that "The usual surface application is not sound from a physical standpoint. The ratio between undesirable surface effect and therapeutic effect at depth is such that a lethal tumor dose may mean permanent damage to the surface. Blood supply to the surface epithelium is interfered with directly as well as fibrosis underlying the scar."

DISADVANTAGES

The necessity of hospitalizing most of the patients treated by this method may prove a serious drawback in some instances. For this reason other less desirable methods may occasionally have to be resorted to. The treatment is impractical for use on small uncomplicated lesions which can be satisfactorily treated by other methods.

The following indications have largely determined our selection of cases for this method:

(1) Rapidly growing or advanced prickle cell carcinoma in any location on the skin.

(2) Extensive basal and baso-squamous cell carcinoma of long standing (Fig. 1).

(3) Deeply growing resistant types of basal cell lesions with sclerosed fibrous tissue changes.

(4) Malignancies over bony prominences such as the malar eminence in which the periosteum or bone may be involved and a comparatively large amount of radiation is contemplated (Fig. 2).

(5) Areas having underlying cartilage such as the eyelids, ear and alae of the nose (Fig. 3).

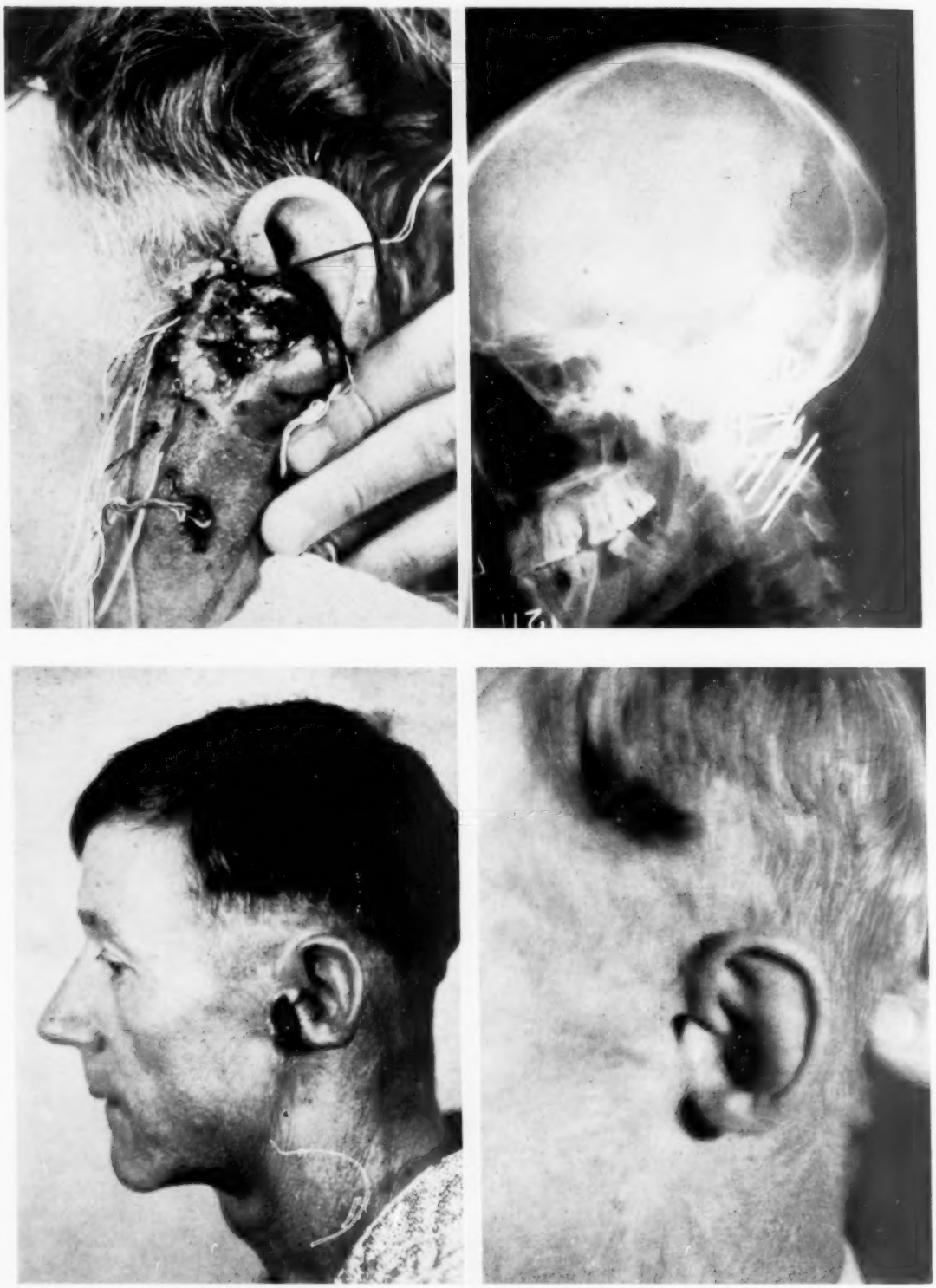

FIG. 3. Squamous cell carcinoma in a patient forty-eight years old. Had been previously treated by electrolysis and a cancer paste. Was complicated by involvement of cartilage and preauricular and postauricular glands. Treated in April, 1930, by radium puncture with heavily filtered low intensity platinum needles. Dosage: 3,034 mg-hr. in seven days. Third view shows partial healing at end of eight weeks. Has remained well over four years.

(6) Infiltrating and extensive lesions over underlying fascia in the temporal region, inasmuch as the method lessens the danger of radionecrosis of the outer table of the skull with resulting sequestrum formation. The same is true for lesions anywhere on the scalp.

(7) Epitheliomata overlying dense integument such as is found in the region of the angulae alae nasi, as they heal with a less dense fibrosis.

(8) Recurrences following surgical excision, electrosurgical methods or the actual cautery in which cancer cells are interspersed in the scar tissue (Fig. 4).

It is not rare, however, to find such extension by emboli and sometimes by direct permeation of the preauricular and postauricular nodes. In these locations interstitial irradiation by radium puncture has been, as a rule, successful.

Sometimes prickle cell carcinoma on the face will metastasize to the submental, submaxillary or cervical nodes (Fig. 5). Our experience in treating some of these cases by use of radium puncture supplemented by external irradiation with filtered deep roentgen rays or the use of a Columbia paste radium pack has given splendid results. Our series so treated is

Fig. 4. Basal cell carcinoma. Had been treated in 1927 by electrocoagulation and curettage. Recurrence developed in 1930 and was treated by electrocoagulation, curettage, roentgen rays and surface application of radium. Further recurrence, proved by biopsy, developed in January, 1931. Treated by interstitial irradiation with heavily filtered low intensity radium needles. Dosage: 1,342 mg-hr. in seven days. No evidence of recurrence in May, 1934.

(9) Carcinoma developing in scars of long standing such as those resulting from burns, varicose ulcers and lupus vulgaris.

(10) Recurrences following other forms of irradiation with radium and roentgen rays in sufficient quantities to apparently preclude the further use of radiation in any form. Needless to say, careful judgment must be exercised in the selection of cases in this group (Fig. 4).

TREATMENT OF METASTASES

Fortunately, the difficult problem of the treatment of metastatic involvement of lymph nodes does not occur with anything like the frequency in skin malignancies as is seen in similar lesions of the lips and mouth.

not large and not enough time has elapsed to evaluate it thoroughly. If the involved nodes are extensive and inoperable, it offers the best method of radiation treatment. In operable cases where operation is refused it becomes the method of choice.

The hazard of injury to large vessels by radium puncture is more apparent than real. We have never had such an experience. Fitzwilliams,[5] who has had a large experience with the method, states that he has never seen any trouble following the insertion of needles into metastatic growths in the neck.

Exposure of the nodes by operation permits of far more accuracy in placing the needles, and results should be correspondingly more satisfactory.

CONCLUSIONS

Prolonged interstitial irradiation with heavily filtered platinum iridium radium needles of small intensities is superior to other forms of therapy in the treatment of certain cases of skin carcinoma which, because of extent, location, former treatment, recurrences and anatomical factors, makes them difficult to manage by older methods.

The treatment of metastases by radium puncture supplemented by external irradiation has given unusually good results.

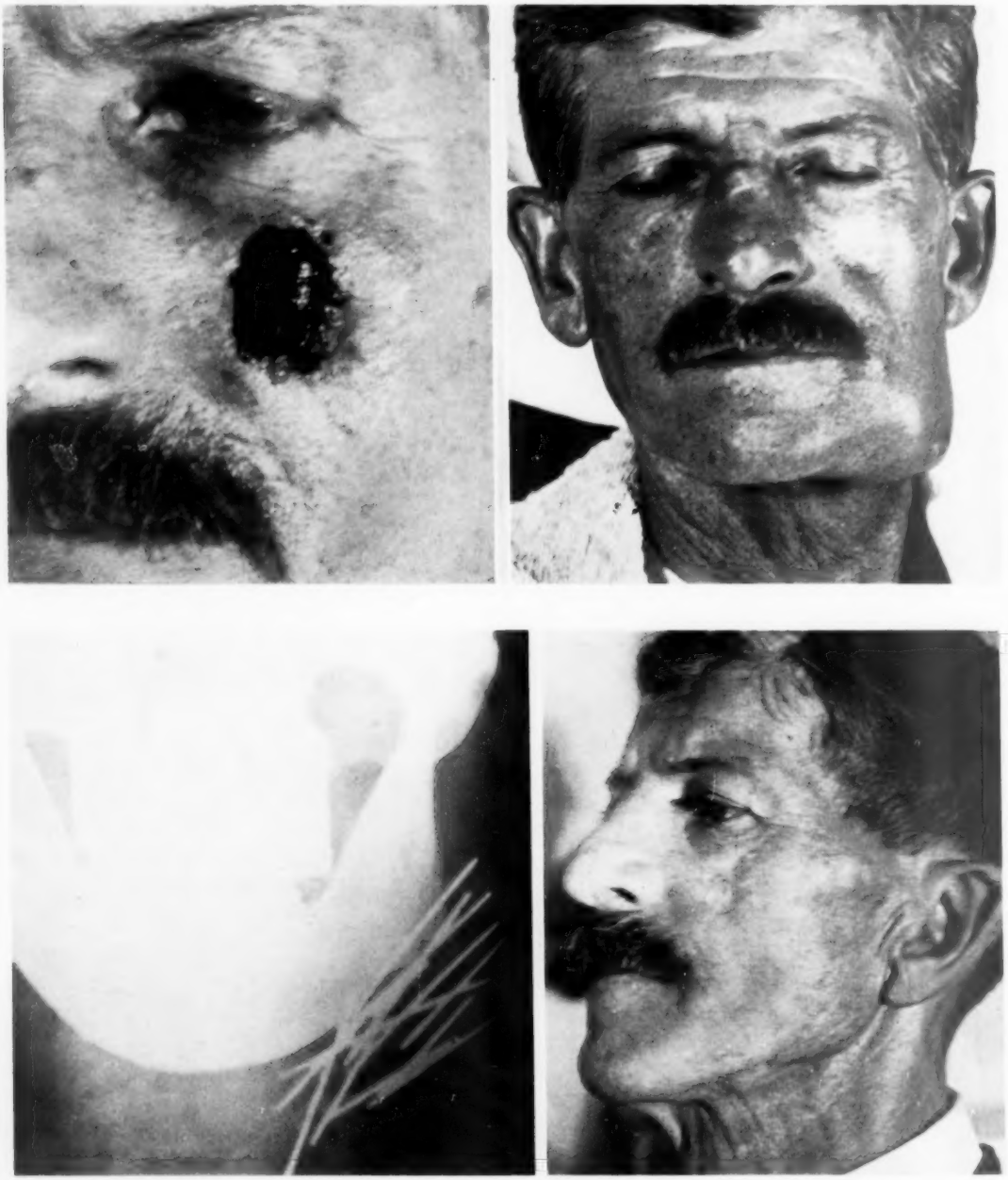

FIG. 5. Prickle cell carcinoma of four months' duration. Treated in January, 1931, by electrocoagulation and surface application of radium. Patient returned November 2, 1931, with a large inoperable metastasis under the left jaw. Metastasis treated by interstitial irradiation with low intensity radium needles, giving a total of 5,544 mg-hr. The last view was taken March 16, 1933. There was complete regression clinically. The patient died in May, 1933, without evidence of recurrence.

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RADIUM DOSAGE AND TECHNIQUE IN CARCINOMA OF THE TONSIL, PHARYNX, AND LARYNX*

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THE doctrines of Regaud and his collaborators concerning the significance of the time factor in irradiation have for many years occupied the attention of radiotherapists, but the further clinical confirmation of these principles by the French school, notably by Coutard, has revived the keenest interest of those who are occupied with the radiation treatment of cancer.

The publication of Coutard's unusual results in the treatment of carcinoma of tonsil, pharynx and larynx has raised numerous questions of theoretical interest and practical importance concerning the formula of radiation.

What is the correct dose of radiation necessary to sterilize squamous carcinoma? What are the minimum, maximum and optimum total time intervals of irradiation? What is the most desirable daily dose and hourly intensity of treatment? Do these factors vary for the different histologic, histogenetic, and clinical forms of cancer?

In this communication I shall limit myself to certain observations on the effect of the total period of irradiation upon the skin, the tumor bed, and the local lesion in carcinoma of the tonsil, pharynx, and larynx treated by the 4-gram radium pack.

A more precise knowledge of the upper time limit of safety for the avoidance of radiation immunity would constitute an important help under numerous circumstances:

1. When the disease is so extensive that treatment must be administered through numerous portals of entry, it is exceedingly difficult and at times impossible to administer the entire cycle in a short period.

2. Rapid administration of treatment is undesirable and dangerous in extensive lesions, especially when they are infected. Under these circumstances a protraction of the time interval is unavoidable.

3. The general condition of the patient often contraindicates intensive therapy, especially if the patient is subject to radiation sickness. A knowledge of the safe, total interval of irradiation would be of great assistance in guiding the rate at which therapy is administered.

4. The ability to treat moderately advanced cancer of the larynx without tracheotomy depends mainly upon the rapidity with which the radiation is delivered. A knowledge of the upper limit of safety at which radiation immunity can be avoided would assist in planning the treatment of these patients.

The dominating principles in Coutard's technique are: (1) correct and adequate dosage; (2) low intensity of radiation; (3) continuity of treatment, and (4) optimum total time of irradiation confined within the safe limits of radiation immunity.

Regaud has estimated that radiation immunity develops six to eight weeks after the beginning of irradiation. A careful study of Coutard's communication indicates his great concern about this factor, and it is interesting to note that he constantly feared the results of protracting the treatment beyond the thirty-day period although his data indicate that a number of lesions were eradicated during intervals of forty, fifty, and even sixty days. In discussing this factor Coutard states: "The average duration of treatment in the cured males has been 30 to 40 days for the tonsillar region; 24 to 31 days for the lower pharynx and 15 to 21 days for the larynx.

"The cancericidal effects do not increase

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.
† Director of Tumor Clinic, Michael Reese Hospital, and Consultant in Tumors, Edward Hines, Jr., U. S. Veterans Hospital, Hines, Illinois.

proportionately with the time of treatment—quite the contrary—the real or apparent loss of radiosensitivity (immunization) of the cells of squamous epithelioma is often appreciable about the thirtieth day after the beginning of the treatment. In the same way the epithelial radiation lesions of the skin and mucous membranes are more difficult to provoke even when the doses are slightly increased, the longer the treatments have lasted."

"Treatment over long periods, from thirty to thirty-five days, has sometimes led us to fear non-sterilization of the tumor, either during or after the treatment because the regression of the tumor was sometimes incomplete two months after the beginning of irradiation."

"In summary, the lengthening of the duration of treatment has seemed to diminish the number of cures, but has seemed to diminish the rapidity of development of recurrences. On the other hand, the shortening of the duration of treatment has seemed to accelerate the rapidity of evolution of recurrences."

It is interesting that since the publication of his results in 1932 Coutard has displayed the tendency to prolong the total duration of treatment.

For the past two and one-half years the Tumor Clinic of the Michael Reese Hospital has had at its disposal two radium packs, one containing 2 grams of radium element and the other containing 4 grams of radium element. This apparatus, designed in collaboration with Dr. Failla of the Memorial Hospital, New York, permits treatment through any of the following portals: three circular portals, 5 cm., 7 cm., and 10 cm. in diameter each, and one rectangular portal 8×10 cm. The filtration is 1 mm. of platinum. The distances have varied from 10 to 15 cm. Most treatments are carried out at 10 cm. distance.

A group of patients suffering from carcinomas of the tonsil, pharynx, and larynx have been placed under treatment as a problem of clinical research. The general plan has been to execute continuity of treatment in divided doses up to a dose which produces the characteristic lesion in the normal mucous membrane around the tumor described by Regaud and Coutard as "epithelitis." In order to accumulate data which may in time be of help in comparing the effect of roentgen rays and radium, the plan of treatment has been constructed to parallel the Coutard technique as closely as possible. The patients are treated twice daily, consecutively without interruption until the cycle is completed. At 10 cm. distance the cycle of irradiation lasts from twenty to sixty days. The duration of each exposure has varied from thirty minutes to one hour and fifteen minutes so that the dose administered at a single irradiation has varied between 2,000 and 5,000 mg-hr. The total doses through one portal on each side of the neck has varied between 90,000 and 190,000 mg-hr. The latter dosage has been made possible by a device in the new radium pack designed by Dr. Failla which permits an increase in the depth without an increase in the dose to the overlying skin.

It is, of course, obvious that no conclusions can be drawn concerning the permanency of any results obtained in this short period, but because of the unusual interest in the time and intensity factors in irradiation I feel justified in presenting some observations which may influence and guide our efforts to arrive at the optimum factors in radiation therapy.

In the belief that a small group of cases analyzed with consideration of all possible factors and treated on the basis of a laboratory experiment may yield accurate information—perhaps more accurate than that obtained from mass statistics—I have selected several cases which are of interest from two points of view: (1) as evidence in the problem of the upper time limit for total irradiation without the production of radiation immunity, and (2) as evidence on the dose necessary to produce an epidermitis and the upper limits of safety in massive radium therapy (Table 1).

TABLE I

Name	Site of Lesion	Extent of Lesion	Metastasis to Regional Lymph Nodes	Microscopical Diagnosis	Dose	Distance	Total Duration
G.E.	Base of tongue, epiglottis and larynx	Very advanced	0	Squamous carcinoma	98,000 mg-hr. left neck; 94,000 mg-hr. right neck	10 cm.	50 days
R.G.	Tonsil	Advanced	+	Mixed squamous and transitional cell carcinoma	124,000 mg-hr. left neck; 124,000 mg-hr. right neck; 140,000 mg-hr. posterior neck	15 cm.	35 days
M.C.	Tonsil and base of tongue	Advanced	+	Squamous carcinoma	156,000 mg-hr. left neck; 160,000 mg-hr. right neck	15 cm.	63 days
S.B.	Tongue and roof of mouth	Advanced	+	Squamous carcinoma	188,000 mg-hr. left face; 192,000 mg-hr. right face	10 cm.	42 days
M.G.	Intrinsic larynx	Early	0	Squamous carcinoma	88,000 mg-hr. left neck; 91,000 mg-hr. right neck; 12,000 mg-hr. anterior neck	15 cm.	41 days

DISCUSSION

Five patients are presented suffering from relatively radioresistant, adult, squamous carcinomas. The lesion was early and localized in 1 case and advanced in 4 cases. Complete disappearance of the lesions was accomplished in all the cases by protracted radium pack therapy. The lesions were exposed twice daily and consecutively. The distances were 10 and 15 cm. An epithelitis was produced in every instance and an epidermitis in 3 of the 5 cases. These observations are presented to demonstrate a primary disappearance of disease in response to protracted irradiation. The patients have been free of disease for periods varying between nine months and eighteen months. The short interval since treatment permits no deductions whatever upon the permanency of the results. These observations, however, seem to confirm the possibility that if continuity of treatment is observed and the total dose is adequate, the total period of irradiation may be prolonged to forty, fifty, or even sixty days without necessarily inducing a radiation immunity. Although it is possible that local recurrences may still develop in these cases because of the short time interval, it is much more likely that reappearance of the disease—if it occurs—will take place in the form of metastases to lymph nodes outside the field of irradiation or to distant viscera.

CONCLUSION

If the principle of continuity of radiation is respected and the total dose adequate, it would seem that initial sterilization of

squamous carcinoma can be effected even though the total time is prolonged over periods varying from thirty to sixty days.

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DESIGN OF A FLEXIBLE RADIUM BOMB WITH ADEQUATE PROTECTION, DELIVERING A HOMOGENEOUS FIELD OF RADIATION AT VARIOUS DISTANCES*

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IN February, 1932, there was some indication that we might secure 4 grams of radium to be placed in a pack, so we began at that time to study the various containers which had been constructed for this purpose. After some time, we arrived at the following basic points to be considered in the construction of such a container:

1. The apparatus should be flexible.
   a. The apparatus should be flexible enough to treat a patient at any desired position or angle.
   b. The apparatus should be flexible enough to treat a patient at any desired distance.
2. The operator should be protected as nearly 100 per cent as possible.
3. The radiation over the area, the size of the portal should be homogeneous for a given distance.

In reviewing the literature, we did not find an apparatus that met these requirements to our satisfaction. Mr. Russell, Chief Engineer of the University of Pennsylvania, suggested that we try to utilize the principle of a gun, placing the radium on a holder which would simulate the projectile. By using this principle, we are able to move the radium up and down within the bore (recess) of the lead container, treat at a target skin distance of from 4 to 25 cm., and at the same time keep constant the size of the skin area being irradiated.

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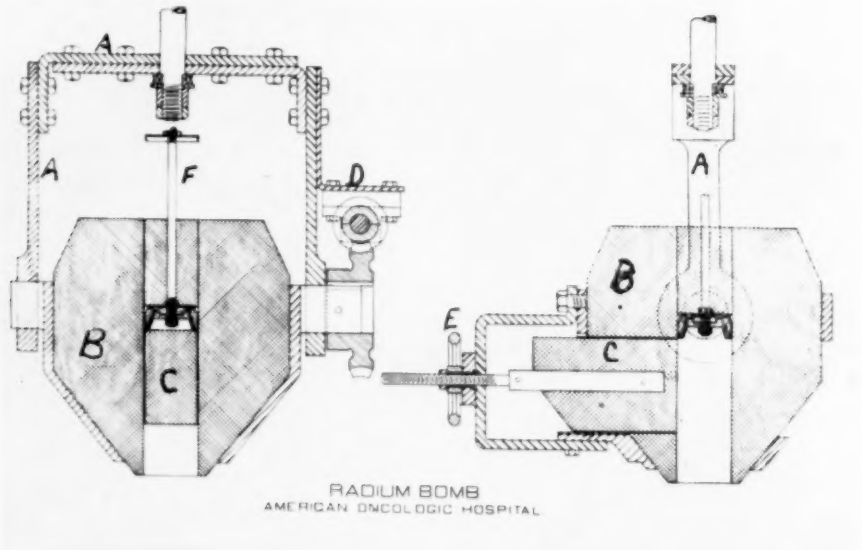

FIG. 1. *A.* Steel frame. *B.* Lead (antimony 6 per cent) casing. *C.* Plug that closes the port which is operated by an electric motor. *D.* Worm gear for angular movement. *F.* Movable device for holding the radium cells. See Figure 2.

* From the Radiological Department of the American Oncologic Hospital, Philadelphia. Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

that 15 cm. (6 in.) of lead gives a maximum protection for 5 grams of radium. We have used this amount of 6 per cent antimony lead on all sides in the construction of this apparatus (Fig. 1).

To protect the operator from the rays that come through the treatment portal while the patient is being placed in position for treatment and also for complete protection when the apparatus is not in use, we use a plug of lead 6 in. thick and the width of the portal. To open and close this portal rapidly with the plug which weighs 63 lb., we use a 1/70 h.p. reversible motor and a train of compound gears, the lowest gear of which is fastened to a screw stem which in turn is attached to the plug. It requires fifteen seconds to open or close the portal. A handle on the lower gear permits opening of the plug by hand if it should be necessary. A cut out switch is placed on a saddle above the bomb which closes automatically when the radium is out of the path of the plug. The position of the radium in the recess of the portal is controlled by a cord and pulley, the cord extending to the control room. The weight of the holder is sufficient to take it down. Blocks of various height are placed under the stem to retain the radium at desired points.

To secure maximum flexibility, a steel frame was constructed consisting of two bands, one band being at an angle supporting the tapered end of the apparatus, the other circumscribing the lead at its largest diameter. These two bands are connected by a plate. This is made rigid to the lead by means of steel bolts extending into the lead. On each side of this large steel band, two trunnion pins are welded, one of which is 3 inches longer than the other. From these trunnion pins, the apparatus is swung as a bucket. To the longer trunnion pin a worm gear is fastened. The shaft from the smaller worm extends laterally 9 inches, to which a hand wheel is attached which permits the bomb to be moved within a radius of approximately 300° allowing treatment at any point within this range. To permit complete rotation of this apparatus, we use a ball-bearing swivel joint, connected to the shaft from which the apparatus is swung. This design allows rotation as the sun to the orbit.

Sievert of the Radiumhemmet, Stockholm, states that: (1) a fixed type of bomb is preferable; (2) lateral movement is not essential as the operating table can easily be moved if suitably designed; (3) all adjustments must be very accurate with no vibration or play. With these three points in mind, and realizing the great expense and danger in raising and lowering an apparatus of this weight, we decided to swing our bomb from a shaft and have it fixed, using an ordinary operating room table with a hydraulic lift on ball-bearing coasters and locks to give us the desired flexibility (Fig. 2).

Fig. 2. Radium bomb in operation.

Our radium is contained in 80 tubes of 50 mg. each. Each tube is 30 mm. long

and 2.3 mm. in external diameter, with a wall thickness of 0.5 mm. platinum. With these figures we asked the physicist to give us a layout for the arrangement of the tubes so as to secure a homogeneous distribution of the rays over a given field. This appeared to be a simple problem, but with some thought, the marked complexity of it was evident. Since these tubes placed side by side would cover a total area of 55.2 sq. cm., they could not be concentrated in any portion of a field of this size without overlapping of the tubes. In view of this fact, mathematical calculations were abandoned until after the radium was received.

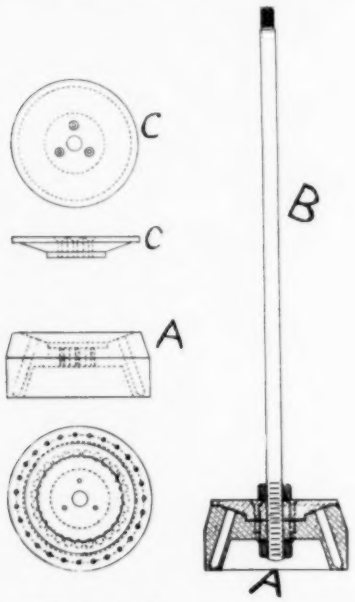

FIG. 3. *A*. Cell for holding radium. *C*. Cap for sealing. *B*. Rod for raising and lowering the cell.

Mr. Weatherwax suggested that we use the "trial and error" method and place the tubes in various arrangements, exposing a roentgen film in each arrangement, and then study the film under a densitometer to determine the homogeneity of the density of the exposed film and thereby determine the best arrangement of the tubes. To do this three working models were made. These models were tubes of lead with a wall thickness of 2 inches, with the following diameters: 3, $3\frac{1}{2}$, and 4 inches, and $4\frac{1}{2}$ inches long. For this experiment, we used only 40 tubes of radium. Films were exposed with the tubes in each of the following positions, using a 3 in. diameter: (1) 40 tubes on a plane in cartwheel formation, the tubes at the periphery of the circle, leaving a hub in the center, 1.6 cm. in diameter, which did not contain any radium; (2) 32 tubes on a plane in cartwheel formation and 8 tubes placed around the periphery of the circle simulating the rim of the wheel; (3) 24 tubes in cartwheel formation and 16 tubes placed around the periphery at the rim of the wheel.

The above three experiments were repeated twice using a diameter of $3\frac{1}{2}$ and 4 inches. After these various films were checked with the densitometer for homogeneous fogging, we found that the most homogeneous area was secured when we used a diameter of $3\frac{1}{2}$ in. (9 cm.) and when all of the tubes were placed in cartwheel formation, leaving a hub of 3 cm., which did not contain any radium. This arrangement did not give us a homogeneous distribution over the field. There was a difference of approximately 17 per cent greater density in the center than at the periphery of this field.

In consulting Dr. Swann of the Bartol Institute, he suggested that we use a cup instead of the plane, and that we angle the tubes so that the end of the tube nearest the hub of the wheel be raised farthest from the patient (Fig. 3). Similar experiments were carried out, placing the radium tubes at several different angles and it was found that an angle of 70° gave an approximately homogeneous distribution of rays over a field the size of the portal. In running the above experiments a total of 46 separate roentgen films were exposed and studied for homogeneity.

In the construction of the holder for these tubes, we ran into difficulties because to place 80 tubes in a cartwheel formation around a circle $3\frac{1}{2}$ in. in diameter would more than take up the space available. We attempted to stagger these tubes, placing every other tube over the adjacent

tube at the hub. When this problem was given to the mechanic, he reported that it was not feasible so we compromised by placing three tubes in each hole, making 27 holes at an angle of 70°. The holder is made of cast aluminum. After the bomb was constructed and the radium in place, films were exposed at various distances from 8 to 25 cm., and the fogging studied with a densitometer for homogeneity. There were no detectable variations within the 9 cm. field, and this was confirmed by Mr. Weatherwax and Mr. Robb, physicists at the Philadelphia General Hospital. This was rechecked by Mr. Locker by a very sensitive densitometer and it will be noted that in the general field the line is almost straight with a slight curve at the ends (Fig. 4).

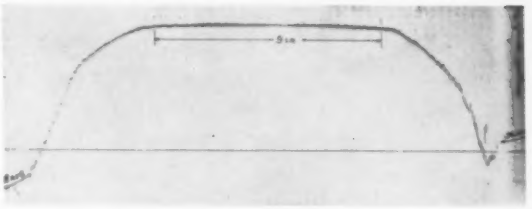

Fig. 4. Densitometer tracing showing the homogeneity of the field.

CONCLUSIONS

1. The apparatus is flexible.
   a. A patient may be treated at practically every desired position or angle.
   b. By the use of one portal a patient may be treated at a target skin distance of from 4 to 25 cm. and at the same time keep constant the size of the skin area being radiated.
2. The operator is adequately protected from both direct and scattered radiation.
3. The distribution of gamma rays over the area of the portal is practically homogeneous between 8 and 25 cm.

THE USE AND ABUSE OF INTERSTITIAL IRRADIATION*

By ALBERT SOILAND, M.D., D.M.R.E. (Camb.)
LOS ANGELES, CALIFORNIA

INTERSTITIAL irradiation as used in this article covers the application of radium in any form through or underneath the skin and surface membranes of the body. It does not include any body cavity which can be entered through any natural orifice or passageway; therefore, I shall discuss the use and abuse of radium as employed interstitially by the radiologist or by the surgeon. There are two main prolific sources of radium abuse, first, through the promiscuous rental of radium applicators by firms or individuals, and second, the ease with which anyone, irrespective of his fitness, may purchase radium emanation seeds from various physical laboratories. It is admitted that a certain proportion of rented radium or purchased emanation seeds falls into the hands of qualified operators, but it is a well-known fact that a goodly portion is distributed to those who are not fit either by education or experience to make proper therapeutic use of this singularly exacting branch of modern medical practice. Hence, we hear constantly that radium is no good for this or that and that so and so was terribly burned by radium and that no one should ever use such a fearful and mysterious destructive agent upon human beings. This statement is no exaggeration and until we can curb the source of such supply it will be difficult for the qualified radium therapist to successfully counteract this vicious propaganda. It appears hopeless to attempt any local regulation to stop this nefarious practice, either by city, county or state laws, but perhaps through a federal appeal some curtailment of this activity may possibly be secured. The radiologist or the qualified surgeon may, from time to time, find it convenient to purchase gold or platinum emanation seeds and this is a legitimate professional procedure, but I can think of no excuse which will justify a general practitioner or a surgeon without adequate radium knowledge to rent and use personally radium in any form, type or quantity. The sooner this vicious cycle is broken the quicker radium will become an agent of precision in those certain types of cancerous disease where its proper application achieves results not yet attainable by any other form or method of treatment, either surgical or medical. Radium is by no means a universal remedy, and as for the interstitial method, this is definitely limited and is to be used only for such localized conditions as give a reasonable assurance of success. I have heard papers read and have seen motion picture films of the treatment of metastatic cancer of the deep pelvic glands where the use of such implantation is not only contraindicated, but the surgical operation necessary to reach these glands is hazardous and the procedure useless from every standpoint. A consideration of the anatomy of the pelvic lymphatics with its network of minute vessels, any of which may contain cancer cells extending by permeation or embolism, should cause one to realize how difficult it would be to distribute gold radon seeds throughout this system by any definite geometric plan whereby one could hope to secure a homogeneous dosage of sufficient intensity to destroy the metastatic cancer involvement. Not only would the above procedure be an anatomical impossibility, but to those familiar with the physics of the action of a radon seed, it can be understood how such a method could produce serious damage to important pelvic structures by too great intensities in unequally distributed areas.

When we speak of the individual who is

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

qualified to use interstitial irradiation, we mean that person, be he surgeon, radiologist, internist or pathologist, who has a basic fundamental knowledge of radium and its action and reaction upon living cells. A surgeon who attempts radium implantation without this knowledge is just as much a menace to society as is the non-surgical radiologist who attempts his own operation for the purpose of implanting radium. Whenever any deep radium implantation is contemplated, the surgeon should operate and the radiologist direct the distribution of the seeds or needle implants. If this happy combination could be universally established, the recovery percentage would be augmented proportionately. After all, the indications for seed or needle implantation are gradually becoming more circumscribed. In cancer of the cervix uteri they were discontinued years ago. In cancer of the prostate, except in favorable cases under open operation, other types of irradiation are superior. In more superficial glands, as of the neck, jaw, breast, axilla and inguinal regions, results are better. In deep metastatic glands throughout the body generally they have not produced anticipated results. In certain types of carcinoma of the breast, both primary and secondary, satisfactory responses are observed. The tongue is a more satisfactory organ to treat with radium seeds than any other, while conversely, the breast and superficial glands already enumerated react more favorably to the heavier platinum filtered radium needles. Our own clinical group is quite partial to the needles, as we have made constant use of them for approximately fifteen years. Difficulties are encountered in cancer of the bladder and rectum. In the latter instance there are a few patients on record who have been relieved of non-obstructive localized lesions on the rectal walls, particularly where these were not ulcerating and did not involve the entire mucosa, as in the annular variety. Another field where the needle or seed excels is in the squamous variety of superficial cancer which is somewhat radioresistant, especially when attacked by surface applications. These, however, will suffice in most cases but experience has shown that implanted radium, when not in direct contact with bone or cartilage, will destroy the average radioresistant tumor when the size and location of such a tumor are within reasonable limits.

In this brief discussion it will be noted that it is limited to a few remarks concerning interstitial irradiation. It was not intended for a detailed study which would be not only tedious but time consuming. The thought uppermost was to call attention to the abuses which this important branch of medical science is subjected to in order that some practical suggestions for their curtailment may be offered by the members of the Society. To the American Radium Society this question is pertinent, for while we may not be our brothers' keepers, yet the sins of our indiscreet medical brothers fall upon us heavily, as we suffer in direct proportion to the amount of irresponsible radium work which is foisted upon our cancer bearing public.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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20th Annual Meeting: Atlantic City, N.J., June 10–11, 1935.

EDITORIAL

DIAPHRAGMATIC HERNIA

THE recent widespread publicity given to a case of so-called "upside down" stomach in a patient who traveled from Nebraska to Fall River, Massachusetts, for an operation serves to call attention to a relatively infrequent, though not a necessarily rare condition.

Diaphragmatic hernia has been known for a long time, chiefly since Louis Petit's first cases were reported by his student Lesne in 1774.[1] There have been recurrent reports of this condition, and with the advent of motorized transport the traumatic type has become more prevalent. Numerous classifications of diaphragmatic hernia have been given, but roughly they may be divided into two types: the congenital and acquired. The most frequent form of the congenital hernias are those which occur through the left leaf of the diaphragm due to lack of its development or to some developmental defect in its musculature. When the left leaf of the diaphragm is completely absent at birth, the stomach, together with most of the small intestine and a portion of the large intestine, will be found in the left chest. These infants are either born dead or die within the first twenty-four or forty-eight hours or shortly thereafter. Patients with herniations of a lesser degree which are of the congenital type may survive and present symptoms of difficulty in breathing or some gastric or intestinal disturbance.

Herniation through the diaphragm has certain points of predilection, namely, the retrosternal or parasternal foramina or so-called foramina of Morgagni, through the left dome of the diaphragm, or through the costovertebral region on the left side due to a non- or maldevelopment of the left crus. By far the most frequent herniations are those that occur in the esophageal region where the normal anatomical esophageal hiatus is replaced by a large defect due to non-development of the crura or the so-called paraesophageal hernia where the esophagus is of normal length and the hiatus is normally developed anatomically but is dilated. Unfortunately this form of herniation, though frequent, often goes unrecognized both clinically and roentgenologically. It may be and usually is productive of symptoms but owing to the fact that it occurs so frequently in the so-called gallbladder type of individual the actual presence of gallstones may mask or obscure the presence of the herniation of the stomach through the esophageal hiatus, if the patient is not carefully examined with this possibility in mind. It is only in the supine or Trendelenburg position that herniations of this character may be roentgenologically demonstrated and too often these positions are neglected in roentgen examinations of the gastrointestinal tract.

The importance of recognizing this type of lesion needs emphasis because of the variability of the symptoms which the patient may present. Some patients may complain of difficulty in breathing, others of typical anginal attacks where the pain is referred to the left arm and left shoulder, and in still others the symptoms may be only a sense of discomfort referred to the epigastric or retrosternal region. This type of epigastric discomfort is seen very frequently in pregnancy where the intra-abdominal pressure has caused a relaxation of the esophageal hiatus permitting a portion of the stomach to herniate through it.[2]

Numerous observers have reported cases

[1] Morison, J. M. W. Elevation of the diaphragm: unilateral phrenic paralysis. *Arch. Radiol. & Electrotherap.*, May, August and September, 1923.

[2] Rigler, L. G., and Eneboe, J. B. The incidence of hiatus hernia in pregnant women and its significance. *J. Thoracic Surg.*, Feb., 1935, *4*, 262–268.

of diaphragmatic hernia, particularly Hedblom, Harrington, Healy, LeWald, Morrison, Manges and Clerf in this country, and Morison in England. More recently Sir Thomas Dunhill,[3] in his Arris and Gale Lecture delivered at the Royal College of Surgeons in England, has called attention to the prevalence of diaphragmatic hernia and its too frequent non-recognition, and to the fact that it may be provocative of distressing and other very grave symptoms, and he also called attention to a form of diaphragmatic hernia associated with a short esophagus. Elsewhere in this issue will be found a comprehensive discussion of the congenitally short esophagus by Manges and Clerf. They emphasize the importance of recognizing this type of deformity and particularly call attention to the roentgen methods of examination by which this type of lesion may be disclosed.

[3] Dunhill, Thomas. Diaphragmatic hernia. *Brit. J. Surg.*, Jan., 1935, *22*, 475–499.

The roentgen examination, when properly carried out, can do much more than show the presence of the hernia. By a careful study and posturing of the patient and a planned technique, the type and site of the herniation can be determined. It is of practical importance to recognize the various types of herniation because when it occurs through the esophageal hiatus and the esophagus is of normal length, proper surgical procedures can be instituted which will completely relieve the patient of symptoms, whereas in cases of herniation through the esophageal hiatus associated with the congenitally short esophagus no form of surgical procedure can be of assistance. Therefore the roentgenologist should not only be familiar with the various anatomical sites where herniation through the diaphragm may occur, but, as brought out by Manges and Clerf, he should keep in mind the occurrence of the congenitally short esophagus associated with the herniation.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Atlantic City, N. J., Sept. 24–27, 1935.

American College of Radiology
Secretary, Dr. B. H. Orndoff, 2561 N. Clark Street, Chicago, Ill. Annual meeting: Atlantic City, N.J., 1935.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N.J., June 10–14, 1935.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Detroit, Mich., Dec. 2–6, 1935.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Los Angeles County Medical Society
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the fourth Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. H. J. Walton, 104 W. Madison St., Baltimore, Md. Annual meeting, St. Louis, Mo., Nov. 19–22, 1935.

Brooklyn Roentgen Ray Society
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N.Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, General Hospital, Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. Otto Glasser, Cleveland Clinic. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. F. J. Payton, Miami Beach, Florida. Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill. Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind. Annual meeting each February 22 in Indianapolis.

Michigan Association of Roentgenologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting designed by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

New York Roentgen Society
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N.Y. Three meetings a year—January, May, and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Annual meeting, Schenley Hotel, Pittsburgh, Pa., May 17–18, 1935.

Philadelphia Roentgen Ray Society
Secretary, Dr. Thomas Loughery, Germantown Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N.Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital. Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Ray Society
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Secretary, Dr C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

PROGRAM OF THE TWENTIETH ANNUAL MEETING AMERICAN RADIUM SOCIETY

June 10-11, 1935, Haddon Hall, Atlantic City, N. J.

Place of Meeting—Vernon Room

MONDAY, JUNE 10, 1935

MORNING SESSION

9:00 A.M. Executive Session
10:00 A.M. Scientific Session
Address of President—William H. Cameron, M.D., New York
Symposium on Radium Packs
Chairman, William H. Cameron, M.D., New York
10:30 Tissue Doses in Teleradium Therapy. G. Failla, Ph.D., New York.
10:45 Advantages and Disadvantages of Radium Packs. Ira I. Kaplan, M.D., New York.
11:00 Advantages and Disadvantages of Radium Packs. Jas. A. Duffy, M.D., New York.
11:15 Advantages and Disadvantages of Radium Packs. Burton T. Simpson, M.D., and Melvin C. Reinhard (by invitation), Buffalo, N. Y.
Discussion: William H. Cameron, M.D., New York, Rollin H. Stevens, M.D., Detroit, G. M. Dorrance, M.D., Philadelphia.

MONDAY, JUNE 10, 1935

AFTERNOON SESSION

2:00 P.M. Executive Session
2:30 P.M. Scientific Session
Symposium on Biopsies
Advantages and Limitations of Various Types
Chairman, Robert E. Greenough, M.D., Boston
2:30 Incisional Biopsy. John M. Hanford, M.D. (by invitation), and Cushman D. Haagsensen, M.D. (by invitation), New York.
2:50 Aspiration Biopsy. Hayes E. Martin, M.D., and Fred W. Stewart, M.D. (by invitation), New York.
3:10 Endothermy Biopsy. Grant E. Ward, M.D. (by invitation), and Charles Geschickter, M.D. (by invitation), Baltimore, Md.
Discussion: James Ewing, M.D., New York, Robert E. Greenough, M.D., Boston, Jay McLean, M.D. (by invitation), New York.
4:30 Developmental Changes following Irradiation. Wm. S. Newcomet, M.D., Philadelphia.

ANNUAL BANQUET

7:30 P.M. Monday, June 10, 1935
Rutland Room, Haddon Hall
Presiding Officer—President Cameron
Janeway Lecture
The Protection of the Radiologist. George E. Pfahler, M.D., Philadelphia.

TUESDAY, JUNE 11, 1935

MORNING SESSION

9:30 A.M. Executive Session
10:00 A.M. Scientific Session
Symposium on Breast Cancer
Chairman, George W. Grier, M.D., Pittsburgh
10:00 Indications for Radical Surgery. Hugh Auchincloss, M.D. (by invitation), New York.
10:20 Evaluation of Interstitial Radiation in Breast Cancer. Orville N. Meland, M.D., Los Angeles.
10:40 Preoperative Radiation. Frank E. Adair, M.D., and Fred W. Stewart, M.D. (by invitation), New York.
11:00 Radiotherapy in Inoperable, Metastatic and Recurrent Cases. A. U. Desjardins, M.D., and Eugene T. Leddy, M.D., Rochester, Minn.
11:20 Ovarian Irradiation in Cancer of the Breast. Richard Dresser, M.D., Boston.
Discussion: James Ewing, M.D., New York, Dallas B. Phemister, M.D. (by invitation), Chicago, Robert E. Greenough, M.D., Boston, Albert Soiland, M.D., Los Angeles, Henry Schmitz, M.D., Chicago, Maurice Lenz, M.D., New York.

TUESDAY, JUNE 11, 1935

AFTERNOON SESSION

2:00 P.M. Executive Session
Election of Officers
2:30 P.M. Scientific Session
Miscellaneous Problems
Chairman, Maurice Lenz, M.D., New York
2:30 Technique of Radium Treatment of Cancer of the Rectum. H. H. Bowing, M.D., and R. E. Fricke, M.D., Rochester, Minn.
2:45 Technique of Radium Treatment of Cancer of the Body of the Uterus. Henry Schmitz, M.D., and Herbert E. Schmitz, M.D. (by invitation), Chicago.
3:00 Radium in Primary Carcinoma of the Female Urethra. Lawrence A. Pomeroy, M.D., Cleveland.
3:15 Cavernous Angioma; Treatment by Radium and other Methods. Wm. L. Clark, M.D., Philadelphia.
3:45 Vernal Catarrh and its Response to Radium Treatment. E. P. Pendergrass, M.D., and J. R. Andrews, M.D. (by invitation), Philadelphia.
4:00 Diagnosis and Treatment of Malignant Tumors of the Nasal Sinuses. G. A. Robinson, M.D., New York.

Meeting of German Roentgenologists and Radiologists in the Czecho-Slovakian Republic

The chairman, Jaksch-Wartenhorst was able in his opening address, at the Twelfth Session, November 3 and 4, 1934, at Prag, to greet a great number of representatives of governments and friendly associations. The participation both from at home and abroad was quite active at this meeting and there were numerous exhibits held in connection with the meeting.

I. The first chief subject, "Roentgen Therapy in Neurology," had an excellent reporter in Sgalitzer of Vienna. He first took up the roentgen treatment of brain tumors, in which he came to the conclusion that real cure of a definitely demonstrated and not operated brain tumor has not thus far been proved. Results can be obtained only in tumors of the hypophysis. Roentgen rays cause a decrease in the production of spinal fluid so that in hydrocephalus the general brain pressure symptoms and the local symptoms as well can be greatly improved by roentgen therapy. He stated that he had had a certain amount of success in epilepsy, syringomyelia and multiple sclerosis; good results were obtained also in neuralgias, particularly trifacial neuralgia and in sciatica. With reference to dosage he advocated simple fractional irradiation.

Löw-Beer, Prag, reported the radiotherapy of intracranial tumors in which operative treatment is to be considered first; but good results can be obtained with radiotherapy also, particularly in adenomas of the hypophysis. Schönbauer, Hoff, Borak, Wenzel, Kuznicki, Steiner, Bandhauer, Salus and Ungar took part in the discussion of the chief subject and their reports, on the whole, confirmed the findings of Sgalitzer.

Further Lectures on Therapy.

Pokorny, Komotau, reported successful irradiation in hay fever and vasomotor rhinitis.

Melchart, Wien, treated lymphogranulomatosis with large doses and supplemented the local treatment with distant therapy. Bardachzi and Herrnheiser had also used a combination of large fields and distant irradiation with intensive local irradiation.

Herrnheiser reported roentgen therapy in 16 malignant bronchial tumors, among which 5 of the patients are alive and apparently free of tumor. The minimum superficial dose was 9,000 r.

Friedl, Prag, reported 100 cases of permanent roentgen castration by means of a two-field method. Heimann, Breslau, discussed his animal experiments in using hormone of the anterior lobe of the hypophysis to treat ovaries injured by irradiation.

Fried, Breslau, reported the effects of radiotherapy in experimental pneumonia in rabbits.

Borak, Wien, discussed the different forms of hyperkeratoses of mucous membrane caused by roentgen irradiation.

Wasserburger, Wien, reported the radium treatment of carcinoma of the esophagus, particularly the difficulties in obtaining anything more than palliative results. He used a soft stomach tube in which 40–53 mg. radium was distributed over 66–88 mm. An active discussion, in which Heiner, Fried, Borak, Schloss and Melchart took part, confirmed the superiority of radium treatment over roentgen treatment.

Heiner, Joachimsthal, discussed the late results of radium needle therapy of carcinoma based on a material of 100 cases.

Schloss, Wien, reported his method of long-continued radium irradiation of the blood vessels in circulatory disturbances. Among 150 cases, 40 remained permanently free of symptoms. Borak in addition to the peripheral vessels also irradiated the spinal cord centers.

Altschul, Prag, reported the continuation of his animal experiments in the study of the action of radium chloride.

Kornalik, Kolin, reported the biological reactions of incorporated rays in animal experiments.

Tschelnitz, Brünn, reported the etiology

of Joachimsthal carcinoma of the lungs and rejected the assertion that radium emanation alone is responsible for the development of carcinoma of the lungs.

II. Stumpf, Munich, gave a collective review of modern methods of examination of the heart. The reports showed that among the modern methods of examination surface kymography promises good results with relatively little expenditure and that in suitable cases it gives information which cannot be obtained either with roentgenoscopy or with the usual instantaneous exposures.

III. Beutel, Prag, reported the results of bronchography on the basis of 500 cases. No injuries were observed. The method was effective in bronchiectasis, in honeycomb lung, in abscess and gangrene cavities, fistulas and intrabronchial and extrabronchial processes which occupied space. In the discussion Langer spoke of the use of bronchography in children. Herzog reported a case in which lipiodol was not yet completely excreted a year after the filling.

Thorax. Steiner, Teplitz-Schönau, reported the possibility of diagnosis and differential diagnosis in aneurysm of the pulmonary artery.

Abdomen. Gütig, Witkowitz, demonstrated roentgenograms of a polyposis of the whole gastrointestinal tract.

Eisler, Wien, discussed mistaken diagnoses in stomach diagnosis caused by failure to see things that existed, seeing too much and seeing mistakenly. The reports of the lecturer were supplemented by Herzog and Steiner.

Reiser, Prag, demonstrated two diverticula of the stomach at the level of the cardia, a pseudodiverticulum of the stomach and an invaginated diverticulum of the small intestine.

Gurniak, Teplitz-Schönau, reported a fistula between the duodenum and colon with involvement of the gallbladder.

Reimann, Prag, on the basis of 400 examinations, came to the conclusion that the meaning of lack of reflex contractions of the gallbladder and kidney pelvis is that the diseased organ has been placed at rest.

Ungar, Karlsbad, discussed the functional peculiarities of the gallbladder. The chief problems of interest were those of emptying and concentration.

Bandhauer, Prag, reported 2 cases confirmed by operation in which it was possible to diagnose by roentgen examination a concrement that did not give a shadow as the cause of an occlusion of the common duct.

Herzog, Witkowitz, pointed out on the basis of roentgenograms the possibility of mistakes from errors of technique of examination in stones of the kidneys and ureter.

Strnad, Prag, reported cases in which perforations had been made in pyelography by the ureteral catheter. Bandhauer reported similar cases. Herrnheiser called attention to the difficulty in diagnosis of perforation. Weiner discussed the possibility of perforation in ureters that had undergone pathological changes.

Reimann, Prag, showed that intravenous pyelography like cholecystography is chiefly a functional method and in addition to morphological changes gives information in regard to the functional condition of the urinary tract.

Langer, Jr., Prag, reported a case in which an extraction needle was swallowed; it was localized roentgenologically in the descending part of the duodenum and removed by operation. Langer, Sr., discussed the social side of this case, Kalmus the medicolegal side. Kraus, Bandhauer and Reiser reported similar cases.

Heinemann, Prag, reported a case of melanosarcoma of the eye, in which small metastases could be demonstrated in the liver by means of hepatolienography.

Bones. Freund, Wien, discussed the significance of changes, particularly consttictions of the joint fissure in joint diseases. Altschul, Eisler, Reiser and Steiner discussed the problems brought up.

Jaroschy, Prag, demonstrated roentgenograms of a so-called luxation of the

os lunatum with fracture of the scaphoid bone, as well as 2 cases of old fractures of the scaphoid bone.

Kisch, Prag, demonstrated a large number of extraordinarily instructive cases which by comparing the beginning and terminal pictures showed the fundamental characteristics of the stage of healing in the roentgenogram.

Schiller, Wlaschim, and Altschul, Prag, discussed the different forms of changes seen in the roentgenogram in tuberculosis of the knee joint. Among 72 treated cases three-fourths could be discharged able to work.

Bandhauer, Prag, discussed the technique of ventriculography. He discussed the 16 different roentgenograms (4 with the patient sitting, 12 in the recumbent position) which make it possible to judge all parts of the ventricle.

Walter Altschul

SCIENTIFIC EXHIBIT

The Scientific Exhibit Committee, under the chairmanship of Dr. W. E. Chamberlain, are making every effort to have this year's Scientific Exhibit at the forthcoming meeting of the American Roentgen Ray Society at Atlantic City, September 24 to 27, one of the most outstanding and comprehensive yet given. To this end, they have secured a much more ample space than at any of the previous meetings and they have arranged with the Program Committee certain definite hours for daily visits to the exhibit hall where the various exhibits will be personally demonstrated. A third feature will be the use of greatly improved illuminators. Those who anticipate having an exhibit should communicate directly with the Chairman, and it is to be hoped that those who are interested will make such application immediately so that they may be allotted proper space. The Scientific Exhibit Committee is composed of Dr. S. W. Donaldson, Dr. Elwood E. Downs, and Dr. W. E. Chamberlain, Chairman, Temple University Hospital, Philadelphia, Pennsylvania.

PAN AMERICAN MEDICAL ASSOCIATION'S CRUISE

Please note important change in ship, time of sailing, and shortening of Pan American Medical Association Cruise, made necessary by the fact that the steamship "Columbia," which had been chartered, has been discontinued from cruise service. The Officers of the Pan American Medical Association have succeeded in chartering the "Queen of Bermuda," a most luxuriously equipped ship which has a private bath in every room. This, of itself, is a much desired convenience which will be appreciated by every traveling member. Another advantage, in the opinion of many of us, is that the sailing date has been advanced to June 29 from New York, on to Rio de Janiero via the West Indies, returning August 1st. Practically the same itinerary that was contemplated in the original cruise will be carried out. The March issue of the Journal carried an announcement of the cruise.

Albert Soiland
Member Governor of Cruise

MINNESOTA RADIOLOGICAL SOCIETY

The winter meeting of the Minnesota Radiological Society was held in St. Paul, Minn., on March 16, 1935. The following program was presented:

1. Radiography of Sphenoid Sinuses through the Open Mouth.....Edward Schons, M.D., St. Paul
2. Roentgenological Study of the Mastoid with Operative Findings in 230 Cases.....H. M. Berg, M.D., Bismarck, N. D.
3. Biliary Dyskinesia.....Herman Wolff, M.D., St. Paul
4. Comparative Value of Radium and Roentgen Therapy in Various Types of Malignancy.....Charles Drake, M.D., Minneapolis
5. Roentgen Diagnostic Round Table
6. Disadvantages of X-Ray Paper from the Physical Standpoint.....

Alfred B. Green, B. Sc., Oak Terrace, ...Minn.
7. Medical Economics in Relation to Radiology.....Informal Discussion

The annual meeting of the Society will be held in Minneapolis in connection with the meeting of the Minnesota State Medical Association, June 24, 1935. At that time the Carman Lecture in Radiology will be given at the meeting of the Minnesota State Medical Association by Dr. Percy Brown of Boston. Dr. Brown's subject will be, "Value of Fluoroscopy in Roentgen Diagnosis and Carman's Influence upon It."

LEO G. RIGLER, *Secretary*

ACADEMY OF PHYSICAL MEDICINE

The Annual meeting of the Academy of Physical Medicine will be held at the Claridge Hotel, Atlantic City, New Jersey, on June 12 and 13, 1935. Further details of the meeting may be had by addressing the Secretary, Dr. Arthur H. Ring, Arlington, Massachusetts.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

TUMORS OF THE FEMALE PELVIC ORGANS. (Macmillan Surgical Monographs. Elliott C. Cutler, Editor.) By Joe Vincent Meigs, A.B., M.D., F.A.C.S., Instructor in Surgery, Harvard Medical School; Surgeon to Out-Patients, Massachusetts General Hospital; Associate Surgeon, Collis P. Huntington Memorial Hospital; Surgeon, Pondville Hospital, Massachusetts State Cancer Hospital. Witha foreword by Robert B. Greenough, M.D. Cloth. Price, $6.00. Pp. 533, with 261 illustrations. New York: The Macmillan Company, 1935.

Pathology, surgery and radiology as they apply to pelvic tumors are discussed in this volume by a man who has had unusually good training in the first two specialties. The sections dealing with gross pathology constitute the outstanding feature of the book because they are freely illustrated with excellent drawings made from specimens selected for the most part from the author's own clinic. At the close of each chapter carefully compiled statistics from the records of the Massachusetts General Hospital covering the results obtained with the type of tumor under consideration are tabulated. Since each diagnosis has been carefully checked both histologically and clinically and since the clinical work has been carried out by a large group of physicians in a general hospital, these figures are deserving of careful study.

As might be expected, a strong preference is shown for surgical procedures in all instances where the method of choice is questionable. For example, the Wertheim operation is advocated in all cases with early glandular involvement from cancer of the cervix provided the patient can be considered a fair operative risk. The fact that the salvage is less than the operative mortality is not stressed. Radical surgery is also given precedence in the treatment of endometriosis in the face of an acknowledged operative mortality of about 10 per cent. The author states that "the surgical treatment of fibroids is the safest and the surest provided the condition of the patient is good," while on the same page he calls attention to the morbidity following the operation and says that the operative mortality ranges from 1 to 7 per cent.

Unfortunately, the radiotherapeutic sections lack the intimate knowledge of the subject which is so pleasing in the surgical and pathological portions of the book. A series of colored drawings used as a frontispiece portrays a large slough in the cervix persisting four years after the administration of radium for cancer and radium "burns" (an unfortunate term) are referred to frequently as though they might be the rule rather than the exception. Nor is this to be wondered at when one learns that radon seeds are used freely in the vagina and the cervix, and that capsules containing relatively large amounts of radon with only partial filtration and no covering to absorb secondary radiation are considered quite satisfactory for cervical therapy. On several occasions the author insists on using the largest possible amount of radon in a capsule for the shortest possible period of time and the work of Regaud and his associates designed to show the harm resulting from this plan is given scant attention.

The use of roentgen therapy in the treatment of pelvic malignancies is damned with faint praise and the techniques are given in an incomplete manner, indicating that the author has had little personal experience with this branch of medicine. Deep tanning of the skin and severe treatment sickness are mentioned as regrettable complications in the roentgen treatment of fibroids although a prolonged mild technique is advocated. The modern divided dose massive technique for administering efficient deep therapy is mentioned but the reader gains no comprehensive idea of its underlying principles or its possibilities.

In spite of these radiological short-comings the radiotherapist who wishes to thoroughly familiarize himself with the pathology of the many tumors that occur in the female pelvis will find this volume a most valuable addition to his library. It also offers an opportunity to study the best that surgery has to offer along with its attendant dangers,—knowledge that is essential if tumors are to be handled intelligently.

CHARLES L. MARTIN

PRACTICAL NEUROLOGICAL DIAGNOSIS; WITH SPECIAL REFERENCE TO THE PROBLEMS OF NEUROSURGERY. By R. Glen Spurling, M.D., Assistant Clinical Professor of Surgery, University of Louisville School of Medicine. Cloth. Price, $4.00. Pp. 233, with 99 illustrations. Springfield, Ill.; Baltimore, Md., Charles C Thomas, 1935.

This is a well conceived, well written, and extremely useful handbook which will doubtless be of immense aid not only to medical students and interns, but perhaps particularly to members of the medical profession who are engaged in general practice and who wish to find out in a fairly simple and thoroughly practical way how to go about the investigation of patients having neurological symptoms, in order either to make a diagnosis of the condition themselves or to refer the patient to the proper specialist, if this seems advisable and necessary.

The book is very properly dedicated to Dr. Harvey Cushing who has contributed so largely to the advancement of neurology and neurosurgery and with whom the author came in contact during his service as intern and assistant resident at the Peter Bent Brigham Hospital at the time Dr. Cushing served as its surgeon-in-chief.

The book is divided into three principal parts, Part I being concerned with the neurological examination itself, Part II with the cerebrospinal fluid, and Part III with the roentgen diagnosis of neurological conditions.

At the beginning of the book, in Part I, there is a practical outline for a neurological examination. This outline is the one which was developed by Dr. Cushing many years ago at the Johns Hopkins Hospital and thence was brought to the Peter Bent Brigham Hospital, since when in its eventual form it has been used by the majority of his many pupils. As the author says in his preface, "It is probably no better than many other synopses, unless perhaps it points more directly to a neurosurgical goal." After a carefully taken chronological history, the examination takes up certain general observations concerning the head, hair, skin, state of consciousness, and so forth. From there it proceeds to the examination first of the cranial nerves and after that to the various subdivisions of the brain and spinal cord. An important point at the end of the examination is a summary of the definitely positive abnormal findings, both those which are subjectively complained of by the patient himself and the objective abnormalities which are made out by the examiner. A perusal of these positive findings can then lead to further possible specialized examinations from the clues which have been established.

After this outline of the examination, the author takes up a more detailed study of the ways in which the examinations are performed. Here there are many practical and useful hints, together with valuable and instructive simple diagrams, a number of the latter being borrowed from Ranson's Anatomy of the Nervous System and from Homans' Textbook of Surgery.

One important fact is stressed under the general observations in which it is said, "The prevalent conception that tumors of the brain are of rare occurrence in the young is gradually being dissipated. As a matter of record, the incidence of brain tumor in the first two decades of life is almost as high as in any decade in the natural life span." A knowledge of this fact, as the author says, would greatly increase the number of correct diagnoses in this age group and allow them to have earlier and more effective treatment.

One minor error appears on page 20 in a paragraph concerned with the discussion of visual fields. In this paragraph it is said that the "extent of the normal field with a ten millimeter test object and the patient two meters from the screen is shown in Figure V." The extent of the fields depicted in Figure V would be the normal field on the perimeter at the usual perimeter distance, whereas the normal field on the screen at the two meter distance rarely goes beyond the fourth degree on the chart shown. Furthermore, the extent of the fields varies directly with the amount and intensity of the light in which they are taken. Again, on page 23, the author rightly deprecates the use of mydriatics in the examination of the fundus oculi until proper information concerning the size and reaction of the pupils has been obtained. He goes on to say, however, "Except in rare instances, the use of mydriatics is not only unnecessary but undesirable." It would seem to the reviewer that in the majority of cases the use of mydriatics is highly desirable after the information concerning the pupils has been obtained. There are certain conditions which ought to be noted in the peripheral part of the retina which as a rule cannot be seen through

normal pupils. Occasionally these may be of real diagnostic importance.

The remaining portion of Part I, which is by far the largest of the three parts and forms possibly two-thirds of the book, is concerned with the more or less detailed and extremely practical description of the anatomy, physiology, and methods of examination of patients suffering from difficulties localized to certain of the major subdivisions of the brain and also of the spinal cord. The descriptions are clear and are given as briefly as possible, yet they cover the subject fully in all essentials so far as the usage of the handbook is concerned. One point here the reviewer would disagree with and that is a statement on page 94 in which the author says that "nystagmus is nearly always present in cerebellar disease." In the reviewer's experience, nystagmus is not infrequently absent in cerebellar tumors occupying the median line. This situation is fairly common especially in children and young adults. The spinal cord section is admirably done with an excellent exposition of the methods used for the determination of the level of a spinal cord lesion.

Part II concerns itself with the cerebrospinal fluid and here again the author has given a straightforward, simple, and clear review of the physiology and circulation of the cerebrospinal fluid, together with the methods of its examination. Particularly useful are his illustrations of the simple method of doing a lumbar puncture without the elaborate preparation which in many clinics seems to be a rather time-consuming ritual. This method was taught to succeeding generations of surgical house officers and assistant residents by Dr. Cushing and has proved highly useful and practical.

The final part of the book is concerned with roentgen diagnosis of neurosurgical conditions. Here there are many excellent illustrations of roentgenograms depicting the features which should be looked for carefully in films of the skulls of patients supposed to be harboring intracranial tumors. The bony and vascular abnormalities seen in meningiomas are particularly stressed and there is an excellent illustration of the large symmetrical expansion of the sella turcica so commonly seen in the pituitary adenomas. There are likewise depicted a number of illustrations of typical air injections of the ventricles which show abnormalities commonly met with. The shadows cast by spinal cord tumors after the cisternal injection of lipiodol are well shown at different levels.

In the reviewer's opinion, Dr. Spurling is to be congratulated upon having taken the time and thought to put out a book of this character. It is something which has long been needed and will have a wide scope of usefulness when once the profession at large has found out that such a book is on the market. The publisher, Charles C Thomas, has as usual spared no effort in his endeavor to make the book not only useful but extremely attractive.

Gilbert Horrax

Contribution a l'étude radiographique du sein normal et pathologique. By Dr. Alexandre Espaillat-G., de la Faculté de Médecine de Paris, Certificat d'Electro-Radiologie de la Faculté de Paris. Travail de la Clinique chirurgicale du Professeur Gosset et du Laboratoire de Radiologie clinique de la Faculté (Dr. Ledoux-Lebard, Chargé de cours). Paper. Pp. 154, with 18 illustrations. Paris: Librairie Louis Arnette, 1933.

The study of the tissues of the breast roentgenographically is of comparatively recent origin, the first systematic study having been reported by Warren in 1930. The literature has been meager and many are prone to regard roentgenography of the breast as an interesting but not sufficiently practical method to warrant the careful technique and thorough study necessary to become adept in diagnosis. Many persons feel that history, inspection, palpation, and transillumination furnish data to which the roentgenogram can add little except confirmation. Dr. Espaillat believes otherwise and states that in cases where roentgen and clinical findings disagree the microscope has proved the roentgen study more accurate.

His work on the breast is an excellent text, very readable and at the same time scientific and comprehensive. It is composed of two parts, the first of which deals with descriptive and topographic anatomy, histology, physiology and pathology of the breast. The second section is purely roentgenologic and comprises a brief historical sketch, technique of examination, interpretation of normal and pathologic images and a résumé of the author's observations with conclusions.

The description of his findings is excellent but the illustrations are somewhat disappoint-

ing. Of course the nature of the shadows in roentgenograms of this type is such as to render reproduction difficult and no work on the breast could be illustrated as the author would wish.

The reader may, however, after securing roentgenograms of good quality according to the author's technique interpret them in the light of the descriptive text. The author recommends that intensifying screens and Potter-Bucky diaphragm be not used as they sacrifice detail. His technique seems very satisfactory.

All roentgenologists should find in this book a great deal of assistance in perfecting themselves in breast diagnosis.

E. Walter Hall

Symposium on Silicosis. An unofficial transcript of the Silicosis Symposium held in connection with the Trudeau School of Tuberculosis at Saranac Lake, N. Y., June 18–22, 1934. Edited by B. E. Kuechle, Claims Manager, Employers Mutuals, Wausau, Wis. Paper. Price, $5.00. Pp. 99, 1934.

This transcript represents an abstract of papers that were presented in the Symposium on Silicosis at the Trudeau School of Tuberculosis at Saranac Lake, N. Y., June 18 to 22, 1934. Anyone familiar with the subject of silicosis will enjoy this abstract. On the other hand, it in no way represents what is known about silicosis and there is no bibliography connected with this abstract. The authors are authorities, however, and are the ones to whom we look for information on this subject.

The price of $5.00 for this booklet would seem a little high, although the proceeds from its sale are to be given to the Saranac Laboratory for the study of pneumoconiosis.

To illustrate how it would be impossible to depend upon such a manual for information is the fact that the abstract of Dr. Pancoast's presentation takes only about five pages, and what is said of this paper can also be said of others.

Eugene P. Pendergrass

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Lawton, Stanley E. Lateral aberrant thyroid glands. *Surg., Gynec. & Obst.*, March, 1933, *56*, 696–699.

These tumors are quite rare; the author reports 3 cases and was able to collect 49 additional cases from the literature. Diagnosis is extremely difficult and is rarely made preoperatively. Schrager has emphasized the following diagnostic points: (1) The tumor is likely to increase in size at puberty. (2) It tends to vary in size during menstruation. (3) It tends to become cystic. (4) It is usually unilateral; if solid not greater than the size of a mandarin orange. (5) It is of slow growth, smooth, and, if not cystic, of soft consistency. They are usually situated in the anterior triangle of the neck and may occur as single tumors or as a chain of nodules. They are not tender. They show a distinct tendency to malignancy. Although to all appearances these glands may be benign, they have been known to recur after removal and produce metastases. Years ago, Cohnheim called attention to metastases arising from adenoma gelatinosum of the thyroid, a benign tumor. Hinterstoisser, in an extensive study of carcinoma of aberrant thyroid tissue, observed that carcinoma of aberrant glands is less malignant than carcinoma of the thyroid gland proper. Following surgical removal all patients should be subjected to a series of roentgen treatments such as are given for malignancy, even though the tumor appears to be benign. These postoperative roentgen treatments are of great importance as these tumors are radiosensitive.—*J. H. Vastine.*

Wu, Ching. Visceralverschiebung bei Pneumonie. (Displacement of the viscera in pneumonia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 597–607.

In 40 consectuive cases of pneumonia in adults, 5 showed displacement of the heart and trachea to the affected side, 22 showed elevation of the diaphragm on the affected side, and 5 cases which were studied by doubly exposed roentgenograms showed decreased movements of the diaphragm and ribs on the affected side. In 105 cases of pneumonia experimentally produced in dogs the mediastinal contents were displaced in 42 instances.—*E. T. Leddy.*

Morland, Andrew. The formation and treatment of cavities in the lung. *Lancet*, Dec. 9, 1933, *2*, 1311–1314.

The theories advanced to account for the rapidly changing annular shadows are detailed. The theory that annular shadows are caused by air under pressure following partial obstruction of a smaller bronchial tube, the inflation theory, is held tenable and fully discussed. It is doubtful if inflation alone is ever the cause of the annular shadows seen in tuberculosis, these being the joint action of destruction and inflation. The terms "destructive cavities" and "round cavities" are proposed for the terminology of those lesions respectively formed by caseation in tuberculosis, and by the non-tuberculuous bullae resulting from bronchial stenosis. The contrasting pathology and treatment of the destructive, the round, and the fibrotic type of cavities are discussed.—*W. R. Brooksher.*

Anspach, William E., and Wolman, Irving J. Large pulmonary air cysts of infancy; with special reference to pathogenesis and diagnosis. *Surg., Gynec. & Obst.*, March, 1933, *56*, 635–645.

Two cases of lung cyst observed in infants are described. One of the cysts originated as a large lymphangiectatic fluid filled chamber, which evacuated spontaneously and then "ballooned out" with air, producing a fatal outcome. The other, which was not verified by necropsy, showed a constant roentgen appearance over a long period.

Fluid cysts in infants, which are usually mistaken for atelectasis, do not have a characteristic roentgen appearance, but air-containing lung tissue about an area of increased density should arouse suspicion of the presence of a cyst.

The diagnosis of balloon cysts depends upon successive roentgen and clinical studies and upon an understanding of the late stages of pathogenesis. Usually an erroneous diagnosis of pneumothorax has been made. The main roentgen diagnostic points of a balloon cyst are the presence of lung tissue at the apex and angles and its absence at the usual hilar region. A collapsed retracted lung shadow, as in simple massive pneumothorax, is not seen in the film.

Small air cysts, which cannot be differentiated from other air pockets, such as localized pneumothorax, at a single examination will maintain a more or less constant appearance, while the others will show changes and later disappear.

Based upon a study of reported cases and of their own observation, the authors believe that congenital air cysts of the lung are fluid containing at birth, and that their post-natal behavior depends principally on mechanical factors. A classification of congenital lung cysts is suggested.—*J. H. Vastine.*

Conte, E., and Costa, A. Angiopneumographie (Angiopneumography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 510–517.

The authors introduced contrast solution directly into the right heart and so into the pulmonary circulation by means of a sound according to the technique of Forssmann, a procedure which they say is without risk. They feel as a result of their experience that the method is valuable in diagnosis of obscure lesions of the lungs.—*E. T. Leddy.*

Pape, R. Lungentrübung bei Purpura. (Pulmonary shadows in purpura.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 491–497.

The author resports a case of purpura hemorrhagica in which the roentgenogram of the chest showed small flakes and linear shadows in the lung fields, and emphasizes that purpura must be considered in the differential diagnosis of lesions which produce changes similar to those in the roentgenogram.—*E. T. Leddy.*

v. Conta, G. Periarteriitis nodosa der Lungengefässe und Lungenröntgenbild. (Periarteritis nodosa of the pulmonary vessels as seen in the roentgenogram of the lungs.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 506–510.

Periarteritis of the pulmonary vessels is rare. The author reports a case proved by autopsy. The roentgenogram showed congestion of the lungs and round shadows varying in size from that of a pea to that of a cherry. With the object of finding out how large the nodules had to be to be first visualized in the roentgenogram the author cut down five blocks of tissue under roentgenographic control and found out that only those blocks where periarteritis nodosa was present produced a shadow in the film. Both the size and the density of the nodules were increased in the roentgenogram. In cases with periarteritis nodosa and mitral insufficiency (as in his own case) the author feels that roentgen diagnosis is impossible but it is a condition to be considered in those cases which show multiple, fine, flaky, shadows in the lungs.—*E. T. Leddy.*

Edeiken, Joseph. The effect of spinal deformities on the heart. *Am. J. M. Sc.*, July, 1933, *186*, 99–110

An analysis of 26 cases of spinal deformities, mostly of severe grade, involving cervical and dorsal regions is made.

Spinal deformities, especially scoliosis and kyphosis, have a profound effect upon the lungs and this effect is probably the important factor in producing the hypertrophy and dilatation of the right side of the heart noted in many cases. The lung on the side of the deformity is usually compressed, and, while it is merely atelectatic in many cases, Bachman described it as a "tongue of fibrous tissue" in some of the marked cases. A compensatory emphysema on the opposite side further embarrasses the right heart.

Although most patients with kyphoscoliosis and severe grades of scoliosis have signs of right-sided disturbance in cardiac function, they live many years with only restriction in activity because of dyspnea on exertion. Some are cyanotic and a few show edema of the legs. According to the literature most cases die of pulmonary complication.

There are marked changes in size, shape and postion of the heart. In some there is a "mitralization" which appears to depend on two factors: (1) enlargement of the right ventricle; (2) rotation of the heart as the result of the spinal deformity. The aorta tends to follow the spine in spite of the deformity.

Except for axis deviation in 6 instances, the

electrocardiogram was normal in 20 of 24 cases.—*L. H. Osmond.*

Zdansky, E., and Ellinger, E. Röntgenkymographische Untersuchungen am Herzen. 1. Mitteilung. (Roentgen kymographic investigations of the heart. 1.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 648–661.

The analysis of kymographic roentgen films shows the following important points: (1) The kymographic curve of the left ventricular arch is practically an exact volume curve of the left ventricle. This is the first time a curve of ventricular volume has been obtained in man. (2) The kymographic registration of the right heart border gives curves of a different type but which can be identified as characteristic of the auricle and which agree well with the esophagus cardiogram. The course of the kymographic auricular curve is determined not only by changes in the volume of the auricle but also by movement of the atrioventricular septum. Kymographic registration of the right border of the heart shows that many ventricular pulsations are auricular. It was demonstrated, however, that in the diaphragmatic portion of the right heart border purely ventricular pulsations are present which are correctly related to the right ventricle. The exact limitation between the right auricle and ventricle cannot be determined by kymographic registration of the excursions of the heart borders. (3) Kymographic registration of the posterior wall of the heart in the region of the left auricle furnishes an auricular kymogram which differs from the kymogram of the right auricle obtained in sagittal projection by the high and rapid rise course of the phase of auricular filling. (4) Kymographic registration of the left border of the vessels adjacent to the aorta produces a typical arterial pulse curve, that of the right border a typical phlebogram. In many cases the pulsation of the vena cava is marked by the pulsations of the aorta.—*E. T. Leddy.*

Lacchia, Paul. Studienbeitrag zum Lobus inferior accessorius. (Study of lobus inferior accessorius.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 498–505.

The author studied a case in which bronchography led to a diagnosis of a small cystic right lobus inferior accessorius. Exposures taken at various angles showed it to be a three-sided pyramid associated with the bronchus cardiacus. The roentgen diagnosis was checked up by a bronchographic study of lobus inferior accessorius in a cadaver and the relationship to the bronchus cardiacus was demonstrated. Other experiments were made by the introduction of wires in various planes between the interlobar septa in a case of lobus inferior accessorius in a cadaver. These septa may present varying appearances, depending on the angle at which they were roentgenographed, their superposition, etc. The pleural relationships of this lobe may be such that a pocket is formed into which the lung may move during inspiration. This may only partly fill the pocket so that short lines or branched or double lines may result which correspond to the septum of a lobus inferior accessorius.—*E. T. Leddy.*

Fleischner, Felix. Der Lobus inferior accessorius der Lunge und seine Bedeutung für die Röntgendiagnostik. (The importance of the lobus inferior accessorius in roentgen diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 623–644.

From anatomical descriptions and personal investigations, Fleischner discusses the gross morphology of the lobus inferior accessorius and he directs attention to the frequent occurrence of this incomplete separation of the lobes. Thickening of this lobe appears roentgenologically as a basal paramediastinal triangular shadow with sharp almost straight border. It has been regarded in the past as a costomediastinal pleuritis. Gråberger first pointed out its true nature. This variation of separation of the lobes is quite frequent: according to anatomic studies it is incomplete in 35–40 per cent, complete in about 20 per cent of all lungs. In the case of incomplete separation infiltrations in this lobe are sharply demarcated only in certain projections. All sorts of pneumonic processes, even tuberculous pneumonia, occur in it. The occurrence of this structure especially in the young and the predilection of pertussis pneumonia for it may explain the frequency with which it has been observed in children. Often bronchiectasis is observed in this structure. Atelectasis of this lobe may result by swelling of the empty nodes. Even bronchial carcinoma may occur here. Differential diagnosis from mediastino-pleuritic exudates is simple, from costomediastinal

pleuritis more difficult. Displacement toward the thoracic wall during respiration and the "light bronchial tree" (der helle Bronchialbaum) usually make it easy. The lobus inferior accessorius may be visualized when the rest of the lower lobe is infiltrated but the accessory lobe uninvolved. Furthermore, without any parenchymal thickening a delicate linear shadow may indicate an uninvolved interlobar pleura and a broad shadow an interlobar pleuritis.—*E. T. Leddy.*

Peltason, F., and Neumann, Wilh. Die Röntgendarstellung der unteren Pleuragrenze. (The roentgen demonstration of the lower border of the pleura.) *Fortschr. a. d. Geb. d. Röntgenstrhalen*, 1933, *47*, 519–529.

A linear shadow which may appear in a dorsovertebral exposure on the Potter-Bucky of a gallbladder is that of the lower posterior border of the right lung or that of a defective fold of the inferior posterior pleural sinus. An analogous line may appear also in the left subphrenic region. These lines are changed by pathologic process. The authors suggest therefore that the technique for demonstrating the gallbladder be used also for the study of the lower border of the lungs and pleurae.—*E. T. Leddy.*

Palugyay, Josef. Die Luftreliefdarstellung der Speiseröhre im Röntgenbild. (The roentgen appearance of the mucosal relief of the esophagus after injection of air.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 579–596.

Palugyay has adapted Fischer's combined method of examining the colon to the examination of the esophagus. He gives a description of the technique he has worked out, discusses its diagnostic value, emphasizes some of the sources of error and illustrates some of the roentgen findings produced by the method. It promises to be a valuable adjunct to the other methods of examining the esophagus.—*E. T. Leddy.*

Raven, R. W. Diverticula of the pharynx and oesophagus. *Lancet*, May 13, 1933, *1*, 1011–1015.

Acquired diverticula of the pharynx are usually situated posteriorly and are due to a herniation of the pharyngeal mucosa; between the two different sets of musculature comprising the crico-pharyngeus. These differ from each other in their innervation, physiologically and morphologically. In the early stages a spasm of the strong sphincter guarding the esophageal orifice causes a separation of the two divisions of the crico-pharyngeus and herniation commences in the interval thus formed. Were roentgenological diagnosis possible at this stage, further development of the pouch might be arrested by treatment of the muscular spasm.

The roentgenological diagnosis is by administration of a thick paste of the opaque medium, of such consistency that an outline of the esophagus remains for some time after the bolus has passed. Since it is essential to observe the manner of emptying of the pouch, screen examination is important, while the best films are to be obtained in the true lateral position. When the pouch is filled the opaque mixture overflows from the upper aspect into the esophagus. If the pouch presses on the esophagus there will be retention at the site of the stricture. The roentgen appearance may simulate that of a neoplasm. In neoplasms the mixture will flow from the lower level of the dilated portion and the lower border will be conical and not round as in the diverticula.

Congenital esophageal diverticula with esophago-tracheal fistula, tuberculous and large esophageal pouches, are discussed from the roentgenological aspect. Illustrative roentgenograms accompany the article.—*W. R. Brooksher.*

Hamman, Louis. The diagnosis of carcinoma of the lung. *Am. Rev. Tuberc.*, Dec., 1933, *28*, 711–733.

The clinical manifestations of pulmonary carcinoma may be divided into three groups: (1) where the pulmonic growth is secondary to a primary cancer located elsewhere: (2) where the primary growth is in the lung but the first clinical evidence of its presence comes from metastases to distant organs, and (3) where the primary growth is in the lung and the earliest symptoms come from its presence there.

Secondary metastatic carcinoma may occur as (1) small circumscribed nodules, (2) larger areas of infiltration, (3) miliary nodules and (4) pleural lesions. Clinical manifestations are variable and the lesions are revealed, often unexpectedly, by the roentgen ray. The whole

clinical picture may for a time be indistinguishable from that of a pulmonary tuberculosis.

Primary carcinoma of the lung manifests itself clinically as (1) bronchial irritation or compression, (2) a well-circumscribed tumor, (3) an infiltrative pulmonary disease, (4) a pleurisy, usually with effusion and (5) a disseminated miliary infiltration.

The symptoms of carcinoma of the lungs are not different from those of other pulmonary affections, often differing, however, in quality, in intensity and in their combinations. No characteristic physical signs are to be elicited, although a certain combination of signs may be suggestive. For the early diagnosis, attention must be focused upon slight symptoms. The bronchoscope and the roentgen ray are the most valuable aids in investigation.

The differential diagnosis is discussed and illustrative case reports are appended.—*W. R. Brooksher.*

ABDOMEN

TAMIYA, CHICHIO, and NOSAKI, SCHUEI. Röntgenologisch-histologische Studien über die Bedeutung der "Polygraphie" bei pathologischen Vorgängen des Magens. Zugleich ein Beitrag zur Kenntnis des Magengeschwürs mit dem "Riegelsymptom" (Fränkel). (Roentgenologic and histologic studies of the polygraph in diseases of the stomach. A contribution to the recognition of gastric ulcer by the "Riegelsymptom" of Fraenkel.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 672–683.

Malignant changes in the stomach wall, no matter whether one or all the layers are involved, show roughness of contour in that region. By means of the polygraph it is possible to decide by a study of the area whether the process is or is not in the early stage. Further, the polygraph furnishes important information about the operability of gastric carcinoma. The authors' five years' experience shows that the polygraph is indispensable in the study of gastric lesions.—*E. T. Leddy.*

SCHILLING, C., and SAMETNIK, S. Vergleichende pathologisch-anatomische und röntgenologische Studien der Magen-Darmerkrankungen. (Comparative pathologico-anatomic and roentgenologic studies of diseases of the gastrointestinal tract. III. Diseases of the esophagus and stomach.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 411–425.

The authors present a series of roentgenograms and photographs of various lesions of the esophagus and stomach and discuss their relationship to the clinical symptoms. Among the interesting cases are that of a metastasis to the stomach from a breast cancer, and a gastric neurinoma in a woman of twenty-three.—*E. T. Leddy.*

RUCKENSTEINER, E., and KUX, E. Über die Pneumatosis cystoides intestini und die Möglichkeit ihrer röntgenologsichen Diagnose. (Pneumatosis cystoides intestini and the possibility of diagnosing it roentgenologically.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 661–671.

Four cases of pneumatosis cystoides intestini occurring with pyloric stenosis are reported. The ileum was the main point of involvement: there was also involvement of the peritoneal surface of the right diaphragm in 2 cases. Interposition of intestinal coils in 2 cases (one shown by roentgen examination and the other by autopsy) lead to the supposition that this cystic disease predisposes to interposition. In support of this view is the fact that cysts distended the bowel in 2 cases which produced a pneumoperitoneum and pyloric stenosis.—*E. T. Leddy.*

DAVID, VERNON C. Diverticulosis and diverticulitis with particular reference to the development of diverticula of the colon. *Surg., Gynec. & Obst.*, Feb. 15, 1933, *56*, 375–381.

The most commonly observed sites of diverticula are the upper and middle portions of the esophagus, the duodenum, the jejunum (Meckel's diverticulum), the colon and the bladder. The more unusual sites are the larynx, the lower end of the esophagus, the stomach, the ileum, the ureter, the urethra, and the biliary and pancreatic ducts. True diverticula containing all the layers of the structure from which they take origin may be either congenital or acquired and may change into the so-called false diverticula. In the latter the herniating mucosa and submucosa are the most conspicuous—the musculosis being absent.

From a report from the Mayo Clinic, it is estimated that 5 per cent of adults over forty years of age have diverticulosis of the colon. It is rare under forty. The two outstanding etiological factors seem to be age and constipation. The numerous theories of causation are discussed by the author.

The Mayo clinic classification of diverticulitis is used: 1. Self-limited diverticulitis is the most common type. The inflammatory process is limited to the wall of the sac and is characterized by recurrent attacks of abdominal soreness, cramps. irregular bowel habits and gas formation. Treatment consists in a low roughage diet, mineral oil, bella donna, and heat. Enema, irrigation and cathartics contraindicated. 2. Peridiverticulitis. The process may be acute with sudden onset, leading to perforation with peritonitis or chronic with recurrent attacks of local peritonitis with adhesions. 3. Diverticulitis and peridiverticulitis with abscess formation may result in enterointestinal, enterovesical, enterocolic or appendicial abscess. 4. Diverticulitis associated with obstruction of the bowel associated with a large filling defect and tumor formation. The differential diagnosis from carcinoma is not easy and may be impossible to make. 5. Diverticulitis with carcinoma. If there is a causal connection between diverticulitis and carcinoma it has not been clearly demonstrated. That diverticulosis and diverticulitis are often noted in the presence of carcinoma is well known.—*J. H. Vastine.*

GENITOURINARY SYSTEM

Dyes, Otto. Intravenous pyelography. *Surg., Gynec. & Obst.*, March, 1933, *56*, 674–680.

The author cites Haenisch's recent article reviewing the development of this procedure through the work of Roseno, von Lichtenberg, Swick, Binz, Lichtwitz and Hecht.

The pains in the arm and shoulder so frequently observed during the intravenous administration of the contrast medium are a sign that the injection has been carried out too quickly. They are not precursors of thrombosis, a phenomenon which the author has not observed in any case.

The only contraindication to intravenous pyelography is uremia. Usually the less preparation, the more satisfactory is the examination. In ambulant and unprepared patients the presence of gas is less frequently observed. Indications are entirely different from retrograde pyelography. The latter method is of particular value in demonstrating a normal or pathological condition of the lumen of the urinary tract. The intravenous method is less unpleasant, is valuable in demonstrating physiological changes, particularly functional activity, as well as gross changes in anatomy and changes in the size and shape of the renal parenchyma.—*J. H. Vastine.*

Swick, M. Excretion urography by means of the intravenous and oral administration of sodium ortho-iodohippurate: with some physiological considerations; preliminary report. *Surg., Gynec. & Obst.*, Jan., 1933, *56*, 62–65.

The author describes a salt, sodium ortho-iodohippurate, 38.8 per cent iodine, which may be used either orally or intravenously. It is extremely soluble in water, is neutral in solution, represents a product of metabolism, is well tolerated and is quantitatively excreted (95 per cent in six hours after intravenous administration in rabbits). There was no manifestation of kidney damage and no reaction in patients suffering from Graves' disease or hyperthyroidism. For intravenous urograms, between 10 and 15 grains of the salt are dissolved in distilled water in a 40 per cent concentration and are administered over a five minute period. Roentgenograms are made at ten, thirty, and fifty minutes after injection Between 60 and 66 per cent of the iodine is excreted in the first hour, between 70 and 80 per cent in two hours and between 90 and 95 per cent in eight hours.

Oral administration in the human has given encouraging results. Of 14 cases, 50 per cent yielded satisfactory urograms. A dose of 10 to 15 grains dissolved in simple syrup has been attended by no reactions. Roentgenograms are made at ninety and one hundred and thirty-five minutes.—*J. H. Vastine.*

Hinman, Frank. Tumors of the testis. *Surg., Gynec. & Obst.*, Feb. 15, 1933, *56*, 450–461.

The clinical distinction of a mixed tumor or teratoma from a homogeneous monocellular tumor or seminoma is of considerable importance. The latter is radiosensitive and the teratoma is radioresistant. Both are highly malignant and metastasize by preference through the primary lymphatics to the preaortic lymph zone. Sarcoma is now known to be a very rare tumor of the testis. Arranged according to type and extent of disease group I, the seminoma, with or without clinical evidence of metastasis should be treated by radiation either with or without castration; group II, the teratoma with clinical evidence of metastasis, is a hopeless group which can only be treated

palliatively with irradiation; group III, teratoma without clinical evidence of metastasis, are the only cases in which an attempt to perform a radical operation is even indicated. The author summarizes the reports from the literature in addition to sending questionnaires to numerous urologists. He also reports on 14 of his own personal cases. Of 258 patients, treated by orchidectomy with or without irradiation, 110, or 42 per cent, were living. Only 17 of these were for over five years, but since the number of these treated prior to five years ago is not given the actual percentage of cases well over five years cannot be determined. Of 80 cases in which a radical operation was performed, 17, or 21 per cent, were well over five years. Fifty per cent of the 36 cases in which the pathologist could find no microscopic evidence of metastasis were well over five years and 3, or 12 per cent, of the 24 teratomas in which there was microscopic evidence of metastasis to the lymph nodes were well over five years.—*J. H. Vastine.*

SKELETAL SYSTEMS

ELIASON, E. L. Pathological fractures. *Surg., Gynec. & Obst.*, Feb. 15, 1933, *56*, 504–521.

CLASSIFICATION

a. Fragility due to local lesion:
   1. Tumors:
      Benign—cysts (osteitis fibrosa cystica), enchondroma, thyroid.
      Malignant—carcinoma, sarcoma, hypernephroma, endothelioma, multiple myeloma.
   2. Infections:
      Acute—Calvé-Perthes', Köhler's, Kümmell's, Keinböck's, Osgood-Schlatter's disease.
      Chronic—tuberculosis, syphilis, Paget's.
   3. Chemical and pressure causes.
b. Fragility due to general disease:
   1. Neuropathic.
   2. Senility.
   3. Osteoporosis of disuse.
   4. Osteomalacia, rickets, scurvy, etc.
   5. Metabolic disturbances, diabetes, hyperparathyroidism.
c. Fragility due to hereditary disease:
   1. Osteogenesis imperfecta.
   2. Osteosclerosis (marble bones).
   3. Gaucher's splenomegaly.

Fragility due to local lesions. Hydatid cysts affect the diaphyses of the long bones as a rule. Dentigerous cysts of the jaw may be the site of fracture. While fractures through simple cysts often cure such cysts (osteitis fibrosa cystica), fractures resulting from other types of cysts usually require open reduction and curettage.

Osteitis fibrosa cystica including giant cell tumors and solitary bone cysts occur most often in youth and at the metaphyseal regions of the long bones. Although fractures are frequently followed by union with healing of the cyst, follow-up reports have shown that, at least in some cases of fracture, irradiation has given the most lasting cures, probably because parts of the cyst have escaped the curative trauma of the fracture.

Chondroma or enchondroma are benign, usually form at an epiphyseal line and extend distally, expanding widely as they grow. The phalanges are the most common site. Treatment consists in excision and immobilization.

Fracture due to *malignancy—metastatic carcinoma.* The common sites for metastases with fracture are the femur, humerus, ribs, and sternum. Union occurs frequently. *Sarcoma* of bone is usually primary and of the osteogenic type. Union after fractures is possible but rare. The metaphyses of long bones are the commonest sites. Seventy-two per cent (Babcock) involve the lower extremity and 82 per cent of these occur near the knee. *Endothelioma* represents about 7 per cent of sarcomata of bone. The most common sites are tibia, fibula, humerus, ulna and femur. Treatment of fractures in endothelioma consists in immobilization and radiotherapy. Union may occur. Hypernephroma may metastasize to bones, those most frequently involved being the skull, humerus and femur. Metastatic lesions from the thyroid are usually from a malignant adenoma, according to Bloodgood, although other authorities consider the condition nonmalignant. *Multiple myeloma* most commonly affects the ribs, sternum, vertebrae, cranium, ilium, and rarely the long bones. Union may occur but death usually intervenes.

Infection—acute. In pathological fractures due to acute osteomyelitis, union is the rule where immobilization and early drainage have been secured. *Chronic infection—syphilis*—pathological fractures may occur in syphilitic osteomyelitis although the usual local affection of bones is generally a periostitis which results in a thickened cortex and osteosclerosis. Fractures due to trophic disturbances in cerebro-

spinal syphilis are more common. *Tuberculous osteomyelitis* is often seen in the phalangeal, tarsal and carpal bones of children. In adults, a diffuse thickening from periostitis and the formation of a central sequestrum may occur. The long bones are usually involved near the epiphyses, the short bones near the center of the shaft. This condition is more frequent in countries where bovine tuberculosis is more common. *Osteitis tuberculosa cystica multiplex (sarcoid)* involving bone is usually limited to the hands and feet. The lesions are painless. The usual changes are multiple punched-out areas of decreased density, either central or cortical or both. The disease is chronic due to tubercle bacilli, although they cannot always be found nor is caseation ever present. *Paget's disease* is of unknown origin and likely due to an infectious process. It is a chronic, progressive and symmetrical disease, affecting chiefly the long bones, skull and spine. Fractures occur most frequently in the humerus and femur, and union takes place although slowly and following prolonged immobilization. Excessive callus is the rule. Fourteen per cent of the patients with Paget's disease die of osteogenic sarcoma (Codman). Non-union suggests the possibility of sarcomatous degeneration (Bloodgood).

Fragility due to infection of epiphyseal areas. Osteochrondritis deformans juvenilis coxae results in pathological separation of the epiphysis of the head of the femur (slipping epiphysis). Immobilization is necessary to prevent shortening. The slipping tibial tubercle (Osgood-Schlatter's disease) seen most frequently in rapidly growing male adolescents might well be grouped here. Köhler's disease, Kümmell's disease, and Keinböck's disease might be classed as pathological fractures if we consider trauma as the etiological factor.

Local extrinsic pressure such as tumor, aneurysm, metallic band, impacted teeth, etc., may lead to fracture.

Fragility due to general disease—neuropathic. The most common disease of the central nervous system in which fractures occur are tabes dorsalis, paresis, syringomyelia, spina bifida, hemiplegia, and infantile paralysis. The chemical constituents in these atrophic bones making for strength and elasticity are deficient. In tabes dorsalis and paresis the fractures usually involve the lower extremities and are near the joint, which usually shows the typical Charcot changes and is painless. Cotton believes fractures in tabetics to be due to incoordinate but powerful muscle action. Most fractures in tabetics, even with Charcot joints, heal. Fractures in syringomyelia are painless. They usually occur in the upper extremity in contrast to tabes, and most frequently in the left arm. Normal rapid healing is the rule with normal callus. In infantile paralysis union is apt to be delayed and re-fractures to occur.

Osteoporosis of disuse. This condition is frequently observed in extremities that have been immobilized or have not functioned because of paralysis.

Osteomalacia. This is an abnormal softening of the skeletal system, and affects adults primarily. Lack of fresh foods containing vitamins and absorbable calcium has been found to be the cause, the blood calcium being as low as 5 to 6 mg. Bending and deformities of the bones are frequently seen. Treatment of fractures consists in reduction and immobilization of the bones, placing the patient on a normal diet rich in vitamins C and D, and calcium. Union may be delayed if metabolic needs are not supplied.

Rachitis is a hypovitaminosis due to the lack of vitamin D. The bones are deficient in calcium and phosphorus and often contain an abnormal proportionate amount of magnesium and sulphur. Treatment of fractures consists in proper immobilization, attention to diet and vitamin requirements. Good union may be expected under proper treatment. Excessive callus is the rule.

Scorbutus—a hypovitaminosis due to lack of vitamin C is attended by an osteoporosis and periosteal proliferation. Good union may be expected in fractures under proper treatment which consists in immobilization and an adequate supply of vitamin C.

Metabolic disturbances—hyperparathyroidism—cause an extreme generalized osteoporosis, and cystic degeneration of bone. Multiple fractures are frequent, union is slow and re-fracture is likely.

Fragility due to hereditary disease—*osteogenesis imperfecta*—is attended by multiple fractures usually occurring before the thirtieth year. These are due to trivial traumata or muscular action. There is a marked degree of osteoporosis. The long bones of the extremities and the ribs are those usually affected. These patients frequently have blue sclerae. Despite the low calcium content of the bones, fractures heal quickly and with abundant callus. The

blood calcium and phosphorus are usually normal or above normal as in hyperparathyroidism. The immediate prognosis is good, but recurrent fractures and premature death often result.

Osteosclerosis generalisata, or marble bones, is a condition in which the bones are overcalcified and are entirely lacking in elasticity. The fracture line is often straight (transverse) or step-like. It occurs most often in the young. The etiology is unknown but it has been considered to be the result of a hypervitaminosis. Union may be delayed and recurrent fractures are common. The tendency to fracture usually disappears after the age of thirty (Babcock).

Gaucher's splenomegaly is accompanied by an osteoporosis which may result in pathological fracture, most often occurring at the lower end of the femur.

Fragility due to chemical irritation in industry. Fragilitas ossium among match dippers, "phossy jaw," is due to an excess of phosphoric acid in the bones resulting in brittleness. Pearl workers disease (Da Costa) is due to an osteitis from chemical irritation. Arsenic and pyrogallic acid produce a similar ossifying periostitis (Tillman). Destruction of bone with fracture due to mesothorium has been reported by Martland.

The pseudofractures reported by Milkman should be included under pathological fractures but so little is known regarding their etiology that they cannot be classified.— *J. H. Vastine.*

WILSON, PHILIP D. Fractures and dislocations in the region of the elbow. *Surg., Gynec. & Obst.*, Feb. 15, 1933, *56*, 335–359.

Fractures and dislocations of the elbow represent approximately 10 per cent of all fractures and dislocations. The most common injuries in order of frequency were (1) dislocations; (2) supracondylar fractures; (3) fractures of the head and neck of the radius; (4) fractures of the olecranon process.

(1) *Dislocations*: (*a*) Upper end of radius. These are practically always anterior, are associated with fracture of the ulna and are due to a tear of the orbicular ligament, usually requiring open reduction. (*b*) Dislocations of both bones. Of these, 59 per cent occurred under twenty, and were usually associated with fractures of one of the bony elements—the upper end of the radius, the coronoid process, external condyle or capitellum. The special menace of dislocation is calcifying hematoma.

(2) *Supracondylar fractures*. The incidence is greatest in childhood, 92 per cent occurring before fifteen years of age. The lower fragment is usually displaced backward. In the rare flexion type of fracture the distal fragment is displaced anteriorly. Closed reduction is accomplished and maintained by flexion in the former and by extension in the latter type. The great menace of the supracondylar fractures is much more from vascular interruption (ischemia and Volkmann's contracture) than from functional impairment. The radial pulse must be carefully watched during reduction. Frank established that ischemia requires immediate operative intervention. Since this type of fracture occurs most frequently in children, malposition which blocks flexion is corrected over a period of time by the growth of the bone leaving the deformity well up in the shaft beyond the joint.

Fractures of the medial epicondyle are common, usually occurring between the tenth and seventeenth year, and are in reality an epiphyseal separation. It is usually associated with a posterior dislocation. Nothing can be accomplished in the way of direct closed reduction of the fracture but the position of flexion tends to bring about replacements by relaxation of the flexor muscles which are attached to the epicondyle. One complication which may arise is displacement of the epicondyle into the joint. The ulnar nerve which is attached to the medial epicondyle is carried into the joint and pinched, resulting in an ulnar nerve palsy. Excision of the fragment is indicated and is attended by no impairment of function.

Fractures of the lateral epicondyle are rare and usually insignificant.

Fractures of the condyles of the humerus usually extend into the joint surface, and are often T- or Y-shaped, and seriously menace the future function of the elbow joint. The treatment of these is always an individual problem. Closed reduction may be tried but is often ineffective for fractures with comminution or with marked deformity. In these latter cases open reduction and plating of the fragments or treatment in suspension and traction is often necessary. The condyles should never be excised.

Reduction is maintained by flexion in fractures of the medial condyle, and extension in fractures of the lateral condyle.

Fractures of the capitellum—slight displacement of the epiphysis in children is often overlooked and should always be suspected when there is pain, swelling, tenderness and limitation of motion, and the roentgenograms have been reported negative. The capitellum is usually displaced posteriorly and slight degrees of displacement are frequently overlooked by the roentgenologist. The injury is not of great importance but fixation in flexion is indicated. Complete rotary displacement may occur, requiring open reduction. There is danger unless properly reduced of increasing deformity of the lower end of the humerus over a period of years due to absence of growth from the capitellar epiphysis. Fracture of the capitellum in adults takes the form of a separation of a portion of the articular surface with forward and upward displacement and formation of a free body in the joint.

(3) *Fractures of the head and neck of the radius.* These are more commonly observed in adults. In 27 per cent they are associated with other injuries, particularly posteromedial dislocation of the elbow or fracture of the olecranon process. When the epiphysis is fractured and displaced, it is quite likely to become isolated as a loose body in the joint, devoid of blood supply. Fractures of the head and neck of the radius commonly cause serious impairment of function. If in good position the fragments may be so maintained by acute flexion of the elbow. In all comminuted and displaced fractures resection of the head is advisable. Open reduction should be employed in epiphyseal fractures.

(4) *Fractures of the olecranon.* This is usually caused by forcible flexion of the elbow, and the olecranon fragment is usually retracted and separated by the pull of the triceps, the amount of separation depending upon the extent of laceration of the lateral aponeurosis of the triceps tendon. Open reduction is necessary in 40 per cent of these cases, the fragments being sutured together with fascia lata sutures. Fractures without separation may be splinted with the elbow in right angle position for a period of about three weeks. When the separation is slight, good contact between the fragments can usually be brought about by complete extension of the elbow. The results of fracture of the olecranon process are in general excellent. These fractures are complicated in 25 per cent of the cases by other injuries of the elbow, usually of the head or neck of the radius.—*J. H. Vastine.*

HILDEBRANDT, ALWIN. Über Osteochondrosis im Bereich der Wirbelsäule. (Osteochondrosis of the spine.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 551–579.

This is a short treatise on osteochondrosis, a lesion that involves the lumbar spine most frequently and which has, according to the author, no characteristic roentgen appearance. The paper has an extensive bibliography.—*E. T. Leddy.*

GÜNTZ, EDWARD. Beitrag zur pathologischen Anatomie der Spondylarthritis ankylopoetica. (A contribution to the pathologic anatomy of spondylarthritis ankylopoetica.) *Fortschr. a. d. geb. d. Röntgenstrahlen*, 1933, *47*, 683–693.

A case report of early spondylitis ankylopoetica (Brechterew, Strümpell, P. Marie) confirms the majority of reports on this lesion which is regarded as an acute inflammatory disease of the smaller vertebral joints.—*E. T. Leddy.*

NEWELL, R. L. Coccygeal sinus. *Brit. J. Surg.*, Oct., 1933, *21*, 219–228.

The coccygeal sinus (congenital sinus in sacrococcygeal region, pilonidal sinus) produces no symptoms until infection supervenes. Full ramifications of the sinus are demonstrated only by means of the roentgenogram after lipiodol injection. These cavities are lined with true skin and usually contain long hairs. Secondary sinuses are lined by granulation tissue. A coccygeal sinus must be regarded as due to a defect in embryonic development. It is probably the result of traction on the skin caused by retrogression of the tail bud. Treatment consists in removal of the whole of the sinus, together with that portion of the median raphe which contains the origin. The dissection is rendered easier by an injection of paraffin wax immediately prior to operation.

A series of 11 cases is reported, all of which were in women. In no cases have symptoms recurred, the longest postoperative interval being two and a half years.—*L. H. Osmond.*

KIENBÖCK, ROBERT. Über die Arthropathien bei Tabes. (Tabetic arthropathies.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *47*, 379–398; 530–550.

Kienböck presents the roentgenograms and clinical data of 29 cases of tabetic arthropathies which he divides into two groups: (1) hypertrophic arthropathy and (2) atrophic arthropathy or "osteolysis." He discusses their etiology and feels that the roentgen appearance is so characteristic that the diagnosis can be made on it alone and may be the only way of making a correct diagnosis.—*E. T. Leddy.*

BLOOD AND LYMPH SYSTEM

YATER, WALLACE M., and WHITE, CHARLES S. Roentgenographic demonstration of an arteriovenous aneurysm by means of thorotrast. *Am. J. M. Sc.*, Oct., 1933, 186, 493–495.

Progress in arteriography has been due mainly to the use of thorium dioxide prepared in stabilized, colloidal, radiopaque solution under the trade name of thorotrast Heyden. For the arm 10 c.c. is ample, but for the leg 20 to 25 c.c. is necessary. After injection into the arterial lumen the tourniquet is loosened for a brief moment to allow dispersion of radiopaque substance and then tightened again. Roentgenograms are taken in several different views with tourniquet applied.

A beautiful demonstration of an arteriovenous aneurysm in the forearm is shown.—*L. H. Osmond.*

PATEY, DAVID H., TATHAM, R. C., and NICHOLAS, F. G. The use of x-rays in the investigation of varicose veins. *Lancet*, Dec. 9, 1933, *2*, 1309–1311.

The authors report the results of their investigations of 23 cases of varicose veins by injection of uroselectan B and roentgenographic study. Interpretation must be made with care due to the fact that both the deep and the superficial veins show in the film in the same plane. The injection with the patient standing provides, of course, a better demonstration of the condition present. A striking graphic representation of the varicose condition is presented. The procedure is also useful in investigating the relation of apparently scattered collections of varicose veins to each other and to the main superficial venous channels. The roentgen study may enable a determination of the route by which the varicose veins empty and the time which they take to empty under different conditions.

The present study did not reveal any definite information as to whether weakness of the walls or weakness of the valves is the primary etiological factor. In prognosis the roentgen ray may provide some information of value, particularly in showing whether the incompetence of the perforating veins is such that exercise tends to exaggerate the condition.

The failure of the deep veins to thrombose after the injection treatment with sclerosing solutions is not due to the failure of the solutions to reach them, but rather to the rapid flow of blood through these veins as compared with the relatively stagnant circulation in the superficial varicose veins. The importance of stasis in the development of venous thrombosis is thus re-emphasized.—*W. R. Brooksher.*

SIMPSON, R. H. Physiological leucocyte counts and the detection of small deviations from the normal. *Brit. J. Radiol.*, Dec., 1933, *6*, 705–721.

Leucocyte counts have been relied upon as a warning signal in persons exposed to radiation in their occupation. In view of the known inconstancy of the leucocyte count, even in healthy individuals, the author carried out the following observations: (1) experiments designed to determine the accuracy of the technique used and (2) counts of normal individuals. All subjects were in good health and were not exposed to radiation.

Careful and exacting study indicated that small variations must be ignored as of technical origin. White cell counts ranged from 2,800 to 18,100 with polymorphonuclears from 1,600 to 13,100 and lymphocytes from 820 to 4,040. The white cells were found to constantly vary in the peripheral blood, usually higher and more unstable in the afternoon, but fluctuating considerably even when taken at the same time of day. No constant relation between one type of cell and another was noted, hence percentage counts alone are of no value; only the absolute numbers per cu. mm. are significant. Polymorphonuclear and lymphocyte counts may be made with reasonable accuracy but the number of the other cells are so small that estimates of them are valueless for the present purpose.

The author concludes that the absence of any definite standards of the normal makes it extremely difficult to interpret counts which are admittedly not grossly pathological, and to rely upon them as indications of whether or not radiologists have been adequately protected during their work. No significance can

be attached to single counts if they are assumed to be within physiological extremes. The unsupported evidence of leucocyte counts is insufficient to establish the presence of any but gross pathological states with certainty.—*W. R. Brooksher.*

Phillips, G. White. A note on the effect of radiation on the blood. *Lancet*, Sept. 30, 1933, *2*, 745–747.

The lack of agreement by different observers as to the effects of radiation on the blood is discussed. Widely differing and contradictory accounts suggest that there is no fixed standard of "normal" for comparison, an absence due to the fact that the limits of the normal vary widely in different individuals and in the same individual at different times. For this investigation, 9 patients with malignant disease receiving radiation were studied. In no case did an anemia or leucopenia occur. The white cells were not materially altered and while a low lymphocyte count was found, radiation definitely did not produce a lymphopenia.—*W. R. Brooksher.*

ROENTGEN AND RADIUM THERAPY

Willms, Elisabeth. Weiterer Beitrag zur Pathogenese des Röntgenkaters. (The pathogenesis of roentgen sickness.) *Strahlentherapie*, 1933, *47*, 503–516.

The symptoms of roentgen sickness resemble those of hyperemesis gravidarium, the acetonemic vomiting of children and the vomiting seen after anesthesia. In addition to the changes in metabolism that have been described previously, the author found that during roentgen sickness there is an increase of acetone in the blood, particularly of beta-oxybutyric acid. The amount of increase in the acetone bodies does not depend on the duration or dosage of the irradiation. The most intense acetonemia was seen after the irradiation of very vascular organs. It is believed that the acetone bodies come from the products of protein disintegration of the irradiated tissues, analogous to the abnormally rapid protein catabolism in diabetic coma.—*Audrey G. Morgan.*

Chaoul, H., and Adam, A. Die Röntgen-Nahbestrahlung maligner Tumoren. (The close roentgen irradiation of malignant tumors.) *Strahlentherapie*, 1933, *48*, 31–50.

Theoretically, the short wave gamma rays carry greater amounts of energy and have a greater effect than roentgen rays. Practical experience has seemed to confirm this theoretical conclusion. Radium has given better effects than roentgen irradiation of carcinomata in locations where both methods could be used, such, for example, as cancers of the tongue and the mucous membrane of the cheeks and floor of the mouth. It has not been possible to study the reason for these differences until recently, since reliable methods of measurement have been devised. Holthusen compared a roentgen irradiation of 0.37 mm. aluminum half-value layer (30 kv. without filtration) with gamma rays and found that with the same doses there were neither quantitative nor qualitative differences in skin erythema, epilation, or inhibition of the development of ascaris eggs. Englmann found that the morphological changes in tumor cells irradiated with roentgen and radium rays are strikingly similar, qualitatively and quantitatively. The effect of space and time factors on dosage are discussed and the fact brought out that when roentgen irradiation is given from a very short distance its effect approximates that of radium irradiation. This requires a high tension apparatus and special tubes which have been constructed by the Müller firm. Still further work is being done on the construction of these special tubes. Irradiation is given from a distance of from 8 to 11 cm. Two hundred fifteen to 500 r irradiation is given per day to a field. The time for treatment in the beginning was about an hour and a half, with an intensity of 2.5 to 6.94 r per minute, later one to two minutes with an intensity of 286.6 r per minute. The protraction, which was used at first, was given up for fractioning with a very large r dose per minute. The maximum total dose varied from 8,000 to 16,000 r, depending on the reaction of the tumor.

A table is given showing the results in 28 cases treated by this method. Complete disappearance of the tumor was brought about in all cases. So far, at the end of twenty-five months, there have been no recurrences. The time is too short, of course, for final judgment to be passed. The material included two rapidly growing melanoblastocytomas, one of them with regional glands the size of a cherry to that of a plum, an inoperable carcinoma of the lip with submandibular enlarged glands, an inoperable recurrence after carcinoma of the

lower lip, in which radium treatment had been rejected as hopeless, an infiltrating suppurating carcinoma of the lower eyelid, and an infiltrating pavement epithelial carcinoma on the inside of the ear. After healing, the skin remained normal or there was a soft whitish scar. There were no further changes even with doses up to 16,000 r. The better distribution of the irradiation and the sparing of the deeper layers of the tissues with the short distance plays a large part in these good results. The method offers advantages over radium puncture in the treatment of malignant tumors of the mouth. It is more difficult to use it in the treatment of deep-seated tumors.—*Audrey G. Morgan.*

HOLTHUSEN, H. Ueber den gegenwärtigen Stand der Strahlentherapie bösartiger Geschwülste. (The present status of radiotherapy of malignant tumors.) *Strahlentherapie*, 1933, *48*, 15–30.

The author says that it must be admitted that definite conclusions have not yet been reached in regard to either the quality of rays or the size of the dose to be used in roentgen therapy. Increasing knowledge of the mechanism of action of the rays does not give any support to the belief that very hard rays as such are superior in their therapeutic action. This belief was based on two things: the great effectiveness of gamma rays in gynecological carcinomata and the caustic action of soft roentgen rays. A closer analysis of the mechanism of action of the rays has shown that many effects that were formerly attributed to the quality of the rays are really due to the size of the dose and the space and time distribution of the dosage. Efforts at improving the deep action of irradiation have for the most part been devoted to increasing the hardness of the rays but it has been found that much the same effects can be produced by increasing the distance.

It must not be forgotten that the quality of the irradiation at the surface is not the same as that at the deep focus. The rays at the deep focus are much softer than those at the surface. This does not decrease the practical interest in the use of roentgen rays of a hardness similar to that of gamma radium rays, particularly since it seems possible, as shown by the work of Lange in Dresden, to make use of a special space distribution of the radiant energy of the cathode rays produced at very high tensions. There is no doubt that the space distribution of the radiant energy plays an important part in the difference in the therapeutic effectiveness of radium and roentgen rays. For a long time every effort was made to concentrate the irradiation on the pathological focus and protect the normal tissues. But it has been found that the effect on the diseased focus depends to a certain extent on the area of surrounding tissue irradiated and the dosage. There is a relationship between the area irradiated and the dosage that can be borne.

Progress is being made in an understanding of the factors, other than the size of the dose, that enter into the effect of the dosage. The time distribution of the dose is a very important factor. The differences in the effect of equal doses of roentgen and radium rays have to a great extent been explained by an understanding of these factors. The amount of irradiation required to produce a given degree of erythema depends on the intensity. An intensity curve is given showing this effect from which it is evident that there is an intensity above which an increase of intensity no longer increases the effect. A curve showing the effect of fractioning on the erythema dose is also given and compared with the curve for simple protraction of the dose. The total effect of divided doses is less than that of the same amount of radiation given in a single dose. For instance if the dose is divided into three equal parts given on successive days 1,200 r can be given without producing any considerable reaction, if it is given in equal parts on seven successive days 1,700 r can be borne and if given in equal parts on twenty-seven successive days 2,200 r can be given with the same effect.

But prolongation and fractioning of the dosage also increases the tolerance of the tissues so that they can recover from more intense degrees of reaction than after a single dose. This fact has been utilized in the treatment of tumors of the hypopharynx with protracted fractional dosage. These tumors could not be treated by the single irradiation method because of the damage to the normal tissues. Apparently cumulation of dosage differs for different tissues. In the skin the epidermis cumulates more than the connective tissue which shows great regenerative capacity after divided doses or irradiation of low intensity. There is much less roentgen sickness with divided dosage than with single dosage even though the total dose given is much larger.

The muscles, however, are very severely affected by protracted fractional dosage and this is true not only of striated muscle but of heart muscle. The mucous membranes, including the intestinal mucous membrane, react like the epidermis. Simple protraction of the full dose has an effect as well as the fractionating of the dosage.

Tables are given showing the effects of radium and roentgen irradiation on the skin. When roentgen and radium radiation are given in equal physical doses measured in r they produce the same degree of erythema.

It will require further experience to show what the best time rhythm is. The author's method at present in gynecological tumors is to give each parametrium a focal dose of about 2,000 r in nine days in individual doses of 300–320 r. This amounts to about 110 per cent of a skin erythema dose. In addition to this radium is applied locally. He would not advise going above 4,500 r in irradiating large areas of skin and large volumes of tissue.

A graph is given showing the methods of treatment in 1,559 cases of malignant tumor at the St. Georg hospital from 1931 to 1933. It shows that radiotherapy was used in 60 per cent of the cases and surgery in only 23.3 per cent, in 12.4 per cent of which it was combined with radiotherapy. This is an evidence of the very extensive use of radiotherapy in the treatment of malignant tumors at the present time. —*Audrey G. Morgan.*

Jackson, Henry, Jr., and Taylor, F. H. L. Calcium, potassium, and inorganic phosphate content of the serum in cancer patients. Effect of roentgen ray radiation on the level of these substances in the blood serum of cancer patients. *Am. J. Cancer*, Oct., 1933, *19*, 379–388.

The important results and theories of numerous investigations concerning blood serum conditions, especially changes in pH and phosphorus and calcium contents are reviewed, with the conclusion that there are two schools of thought with respect to serum calcium in malignant disease. One represented by DeFermo and Gunther and Greenberg, maintaining complete lack of relationship between the level of the serum calcium and cancer per se, and that headed by McDonald in this country, asserting that there is a distinct etiological relationship between the blood calcium and malignant growth.

With the object of throwing some light on this most important question, two distinct investigations were undertaken. First, an attempt was made to show a correlation between the blood serum calcium and the duration of the disease, the extent of the involvement, the loss of body weight, involvement of the bones and of the gastrointestinal tract, and age in a group of 31 controlled patients suffering from malignant neoplasm. The second investigation was concerned with an evaluation of the changes in the serum calcium through a careful study of the inorganic phosphate and protein in the blood serum, as well as the calcium.

Fifty-two per cent of their cases showed no diminution in blood calcium, while 48 per cent showed a lowering (below 9.3 mg. per cent). Results revealed no direct relationship between the malignant state and the blood calcium. There was no difference demonstrated in the level of either the serum potassium or the serum phosphorus in malignancy. Loss of weight seemed to be the predominating difference. The authors feel that clinical changes in cancer are due to defective nutrition rather than to any intrinsic property of cancer.

The conclusion made from these studies is that there is no demonstrable difference in the level of either the serum potassium or the serum phosphorus in malignancy.—*L. H. Osmond.*

Souttar, H. S. Some special uses of radon seeds. *Lancet*, Aug. 5, 1933, *2*, 285–287.

In certain cases radon seeds alone offer any prospect of success. The author discusses treatment of carcinoma of the base of the tongue, lesions of the soft palate, posterior pharynx and of the esophagus as belonging to this classification. For lesions at the cardiac orifice of the esophagus, a full transthoracic exposure has been employed, inserting radon seeds around the growth. Results have been encouraging.—*W. R. Brooksher.*

Tannenberg, J., and Bayer, L. Der Heilungsvorgang von entzündlichen Veränderungen unter dem Einfluss von Röntgenstrahlen. (The healing of inflammation by roentgen rays.) *Strahlentherapie*, 1933, *47*, 408–425.

Experiments were performed on rabbits. Skin wounds were made and in half of the cases they were irradiated and in the other half allowed to heal spontaneously without treatment. It was found that the irradiated cases healed more rapidly than the others. This in-

creased rapidity of healing took place even when the skin wounds were not made until from three to twenty hours after the irradiation. The more rapid healing is not caused by a real cure of the inflammatory process. The process is only hastened so that it runs its course more rapidly, and therefore healing takes place sooner. The mechanism of the process of healing is discussed in detail.—*Audrey G. Morgan.*

FUHS, HERBERT. Zur Radiumbehandlung zirkumskripter Keratosen. (Radium treatment of circumscribed keratoses.) *Strahlentherapie*, 1933, *48*, 194–198.

The author discusses the results of radium treatment in 280 cases of corns and 154 cases of warts, among them 108 cases of verruca vulgaris and 46 of verruca plana. One to ten irradiations were given, on the average three to five. An average of 20 to 40 mg-hr. was given per field and per treatment, with Dominici tubes with filtration of 0.3 mm. platinum, that is, chiefly beta and gamma irradiation. Irradiations were given at intervals of two to four weeks. Warts at a distance sometimes respond so that in case of scattered verrucae planae on the face and hands only one small field was irradiated, where the warts were thickest. The treatment proved particularly effective in corns of the soles of the feet which are very painful and are hard to treat surgically as scars are often left that are as painful as the corns themselves. It was also particularly effective in the subungual or perionichial form of verruca vulgaris and verruca plana juvenilis.—*Audrey G. Morgan.*

ZEISLER, ERWIN P. Cancer of the skin. *Surg., Gynec. & Obst.*, Feb. 15, 1933, *56*, 472–475.

Epitheliomata seldom develop from a normal skin. Long-continued irritations act as exciting causes such as overexposure to wind and sunlight and occupational hazards in which arsenic, tar, pitch, paraffin, and radioactive substances are carcinogenic factors. The so-called precancerous lesions are: (1) senile keratoses, seborrhoeic keratoses less frequently undergo malignant degeneration; (2) leucoplakia; (3) roentgen and radium keratoses; (4) scars of lupus vulgaris; (5) certain nevi, especially the black pigmented moles and the hyperpigmented lentigines, from which develop the highly malignant melanocarcinoma. Bowen's disease and Paget's disease are now known to be cancerous at the onset.

A great majority of skin cancers about the face are basal cell type and are characterized by slow growth, low degree of malignancy, absence of metastases, and relative radiosensitivity. Treatment consists of curettage and cauterization under local anesthesia, invariably followed by intensive roentgen or radium therapy, but the treatment must be individualized. When cartilage or bone is involved either surgery, cautery removal or electrocoagulation is advised rather than radiotherapy.

Squamous cell or epidermoid cancers of the skin are more dangerous. They are characterized by rapid growth, early invasion of the deeper tissues, early metastasis and a radiosensitivity similar to basal cell cancer. Lesions involving the lip, buccal mucosa, tongue, and penis are of this type. In addition the carcinomata that develop on the site of a preceding radiodermatitis, in the scars of lupus vulgaris, and most of those of the extremities belong in this group. Treatment by electrocoagulation combined with irradiation is recommended. This treatment must be highly individualized, adapting the treatment to the case.—*J. H. Vastine.*

SCHREINER, BERNARD F. Squamous-cell carcinoma of the skin. *Am. J. Cancer*, Dec., 1933, *19*, 829–837.

An analysis is made of cases of skin carcinoma treated at the State Institute for the Study of Malignant Disease, Buffalo, prior to 1927. Cases are divided into two groups: in Group I are placed all those which had not invaded bone, cartilage or tendons at time of admission. Group II includes all those which showed bone, cartilage, tendon or lymphatic involvement.

The treatment of these cases consisted, primarily, of irradiation by roentgen rays, low voltage and high voltage, radium, filtered and unfiltered, surface applications and, at times, the 6 cm. pack. Electrocoagulation and surgery were sometimes employed as curative or palliative measures. Surgery was used in those lesions involving an extremity, with tendon or bone involvement; electrocoagulation was used on the face where cartilage or periosteum of the eyelids, nose or ears was involved.

Among 104 Group I cases available for five year statistics, 54.8 per cent of the patients are alive and well five years or longer. This percentage is low, as 34 cases were lost which had healed. Among Group II cases available for

five year statistics, 6.6 per cent of the patients are alive and well five years or longer. Irradiation was of great value in many of the cases which were not completely healed. The palliative results in a few instances were remarkable. —*L. H. Osmond.*

v. Khreninger Guggenberger, Josef. Experimentelle Beeinflussung von Infektion und Bazillenträgertum durch Röntgenstrahlen. (Effect of roentgen rays on infection and bacillus carrier.) *Strahlentherapie*, 1933, *48*, 103–109.

Individuals working with roentgen rays seem to be particularly sensitive to infections of all kinds, and the course of these infections is very stubborn, suggesting that roentgen rays must create a predisposition to infection. The author tested this question experimentally. A group of white mice were irradiated with a dose of 300 r in forty-five minutes with 1 mm. copper filtration. Another non-irradiated group were used as controls. Both groups were infected an hour after the irradiation. Only one of the non-irradiated animals died with positive bacilli, while 7 of the irradiated animals died. Evidently the irradiation increased the predisposition to infection. Other groups were irradiated with different dosage and it was found that increasing the dosage still further increased the predisposition to infection.

In a further series of experiments bacillus carriers were created artificially by infecting mice first by feeding and four weeks later by subcutaneous injection. Among these animals 18 were irradiated and 12 were used as controls. Two of the irradiated animals died, one on the second and one on the sixth day after the irradiation. None of the control animal died. Fourteen of the irradiated animals showed bacilli in the blood, while the control animals all showed sterile blood.—*Audrey G. Morgan.*

Rose, B. T., and Phillips, F. S. Buccal cancer and its treatment by radium. *Lancet*, July 22, 1933, *2*, 172–178.

The authors report their experience with the use of radium over a period of seven years, discussing (1) some physical aspects of radium therapy, (2) clinical details of treatment, and (3) results. Neither milligram-hour, millicuries-destroyed, energy unit, nor roentgen are thought convenient for calculating the intensity of radiation in the neighborhood of the applicators. The natural method is to consider the intensity of the radiation at 1 cm. from a point source of 1 mg. of radium. Then the radiation at any source can be found by applying the "inverse square law," while the radiation from a number of sources is assumed to be additive. Limiting the application to gamma radiation, assumed to be screened by 0.5 mm. of platinum, such a unit is termed the gamma unit, while the unit of dosage becomes the gamma-hour.

A method of arranging the radium in circular applicators to give a uniform irradiation of the skin is shown, and the maximum dose which may be given the skin when treating glands of the neck is stated, i.e., 300–350 gamma-hours. The clinical methods adopted for the treatment of the primary lesions are described in detail, as are those adopted for the treatment of the gland fields. Interstitial irradiation is preferable in lesions of the tongue, floor of the mouth, inner aspect of the cheek, lip and palate. The treatment of the gland fields is clinically divided into three groups: (1) no enlargement of the glands; (2) enlarged but operable glands, and (3) either the glands are enlarged and fixed or there is diffuse infiltration of the cellular planes with new growth.

The results in 192 cases are recounted. Apparent clinical cures were obtained in 39.6 per cent of all lesions, the best salvage resulting in lesions of the cheek and lip (65 per cent of all cases treated). The ultimate method of choice for the treatment of the gland fields is felt to be irradiation at a distance by a powerful source.—*W. R. Brooksher.*

Asherson, N. Cancer of the larynx; the anchorage of radium in its treatment. *Lancet*, Sept. 16, 1933, *2*, 640–641.

To overcome the difficulty of fixation and retention of radium needles in position and formation when externally applied for post-operative irradiation in cancer of the larynx or pharynx, the author employs either anchorage by means of a woven mesh of catgut or by a silkworm gut tension suture. The technique is discussed in detail.—*W. R. Brooksher.*

Siemens, W. Über die Erfolge der Nachbestrahlung radikal operierter Mammakarzinome. (The results of irradiation after radical operation for carcinoma of the breast.) *Strahlentherapie*, 1933, *47*, 627–630.

At the Roentgen Congress in 1926 general agreement was not reached on the question of

whether roentgen irradiation should be used after radical operation for carcinoma of the breast. The author has collected the cases at the University of Kiel since that time and gives a table showing the results in irradiated and nonirradiated cases, in a total of 508 cases operated upon radically. Group I includes cases in which the tumor was not adherent and there were no palpable glands. Group IIa includes cases in which the tumors were not adherent, but the glands were palpable and generally showed metastatic infiltration microscopically. In Group IIb the tumors were connected with the skin and fascia by adhesions, not infiltrations, and the palpable glands contained carcinoma cells. In Group IIc the tumors were firmly adherent to the pectoralis. There were skin infiltrations or ulcerations and the glands showed metastases. In Group III the tumors were adherent and very large, the supraclavicular glands were involved, and in some cases there were skin metastases. In Group I the results were very good from radical operation with or without irradiation. In Group III they were bad both with or without irradiation. Groups IIa and IIb are the ones which show the good effects of postoperative irradiation with small divided doses. They are absolutely convinced at the Kiel clinic that postoperative irradiation in carcinoma of the breast should be continued.

Since 1923 they have used the intensive reform apparatus. After healing of the wound six to seven irradiations were given at intervals of four weeks over three fields (breast, axilla, supra- and infraclavicular fossae). After an interval varying from two to three months to four to six months, ten to eleven irradiations were given extending up to the end of the second year. The series were interrupted or continued depending on the skin reaction without adhering to any fixed scheme. Doses of 250 to 300 r per field were given, with the distance of 30 cm., 4 ma. and normal filtration. —*Audrey G. Morgan.*

GANTENBERG, R. Erfahrungen über Klinik und Behandlung intrathorakaler Tumoren. (Clinical study and treatment of intrathoracic tumors.) *Strahlentherapie*, 1933, *47*, 426–442.

In the last decade there has been a great increase in the number of cases of malignant tumors of the lungs reported. The majority of authors believe this is a real increase, and not merely an apparent one due to better roentgen diagnosis. This increase is probably due largely to irritation from city dust and automobile gases. In the Schneeberger and Joachimsthal valleys the radium emanation in the air seems to cause cancer.

In recent years the author has seen 16 primary carcinomas of the bronchi, 2 secondary mediastinal and pulmonary carcinomas following carcinoma of the breast, 1 primary sarcoma of the lung, a malignant mediastinal tumor, probably carcinoma, originating from retrosternal goiter or thymus, and a benign intrathoracic ganglioneuroma. Thirteen of the cases are described and illustrated with roentgenograms.

The results in the treatment of intrathoracic tumors depend on early diagnosis. The author's experience with roentgen treatment of carcinoma of the lungs has shown that these tumors are not completely refractory to irradiation as has been claimed. Other authors, too, report retrogression of carcinomata of the lungs and improvement persisting from six and one-half to seven years.

The author irradiated from 3 to 4 fields, using a stabilivolt apparatus, 180 kv., 4 ma., 0.5 mm. copper, and 1 mm. aluminum filter, 50 to 80 per cent of the skin erythema dose to each field in a series. The series was repeated, as a rule, after six or eight weeks. Coutard's method was used in 1 case, and a second case had been treated elsewhere by this method. In 5 of the 20 cases, or 25 per cent, there was very considerable improvement with standstill of the process for some years. This is sufficient to show that irradiation should be begun early and carried out thoroughly. It will require further experience to show whether Coutard's method is to be preferred to other methods.—*Audrey G. Morgan.*

ELLERBROCK, UDO. Zur Therapie chronischer Pleuraempyeme. (The treatment of chronic empyema of the pleura.) *Strahlentherapie*, 1933, *48*, 562–569.

A case of chronic empyema of the pleura is described and illustrated with two roentgenograms, in which the author used roentgen therapy with excellent results. There was an empyema fistula in this case and it is probable that roentgen treatment is indicated only in fistulous cases. The irradiation was given over two fields posteriorly on the right side in the region of the fistula opening, with a focus skin distance of 30 cm. and a dose of 10 per cent of a skin erythema dose (60 R) with a filter of 1 mm. copper and 1 mm. aluminum. Irradiations were given twice a week with a total of 10 irradiations, total dosage 600 R.—*Audrey G. Morgan.*